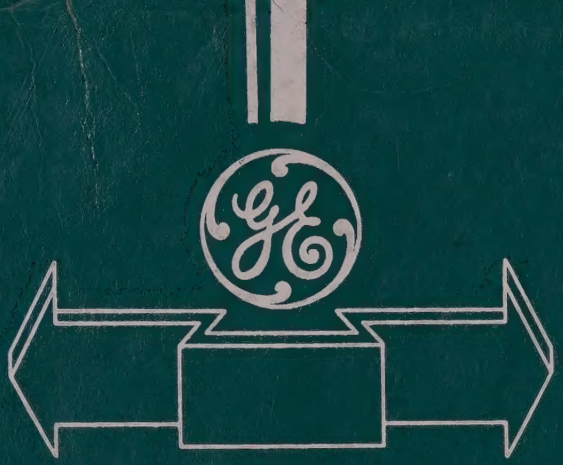


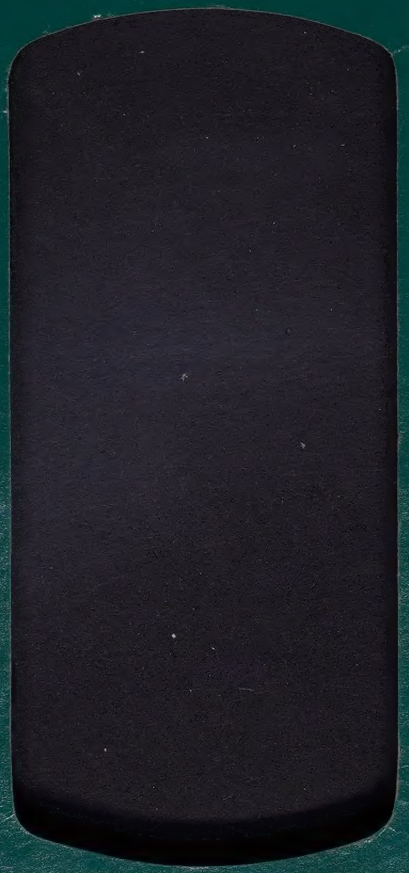
RADIO SET

AN/VRC-32

NAVSHIPS 92652

INSTRUCTIONS

- INSTALLATION
- OPERATION
- MAINTENANCE



1 General Installation

2 Transmitter

3 Receiver

4 Power Supply

5 Control Equip.

6 Access. and Misc.

INSTRUCTIONS
FOR

RADIO SET

AN/VRC-32

NAVSHIPS 92652

2-WAY MOBILE RADIO

GENERAL ELECTRIC
PROGRESS LINE
30-42 MC, 30-WATT
MOBILE COMBINATION
MW13W

EBI-41166
Contract NObsr 64749

ELECTRONICS DIVISION
GENERAL ELECTRIC
ELECTRONICS PARK

Printed in U.S.A.

BUREAU OF SHIPS

NAVY DEPARTMENT

TABLE OF CONTENTS

	Page
GENERAL, INSTALLATION	
General Description	1-1
Installation Procedure	1-2
System Adjustment	1-11
System Operation	1-13
System Maintenance	1-14
Illustration, Typical Mobile Installation	1-17
Installation Outline, Transmitter-Receiver	1-19
Graph, Antenna Length vs. Operating Frequency	1-21
Drawing, Connector and Adaptor Assembly	1-23
Interconnection Diagram, MW13W	1-25
TRANSMITTER	
Specification Sheet	2-1
General	2-3
Maintenance	2-4
Circuit Analysis	2-5
Bench Alignment Procedure	2-9
Parts List	2-13
Stock Number Identification	2-19
Block Diagram	2-23
Service Outline, Simplified Bench Alignment Voltage Resistance Chart	2-25
Service Hints, Typical Metering Voltages	2-26
Elementary Diagram	2-27
RECEIVER	
Specification Sheet	3-1
General	3-3
Maintenance	3-4
Circuit Analysis	3-8
Bench Alignment Procedures	3-11
Discriminator	3-12
4th Low IF	3-12
3rd Low IF	3-15
2nd Low IF	3-16
1st Low IF	3-18
High IF	3-19
Front End Tuning	3-19
Parts List	3-23
Stock Number Identification	3-31
Block Diagram	3-35
Service Outline, Simplified Alignment, Voltage Resistance Chart	3-37
Service Hints, Typical Meter Voltages	3-38
Elementary Diagram	3-39

EQUIPMENT NOMENCLATURE CROSS REFERENCE

The equipment listed below are included in Radio Set, AN/VRC-32 (General Electric Mobile Combinations MW13W) to meet the requirements of Navy Contract NObsr-64749.

AN Nomenclature	GE Model or Drawing Number	Description
CY-1908/VRC-32	PL-7774394-G9	Cabinet. Houses Transmitter, Receiver and Mobile Power Supply
RT-367/VRC-32	4ET22A2	30-42 MC, 30 Watt T ransmitter
	4ER24B2	30-54 MC Receiver
	4EP2G1	6/12/24 Volt Vibrator Power-Supply
C-1847/VRC-32	4EC27A1	Control Unit
LS-255/U	4EZ1A4	Loudspeaker
AT-671/VRC-32	4EY5A2	30-42 MC Antenna and Cable
J-735/VRC-32	PL-7776234-G1	Fuse Box Assembly
CX-3658/U(18'0")	PL-7489268-G1	6/12/24 Volt Power Cable
CX-3659/U(17'0")	PL-7487964-G2	Control Cable

SUPPLEMENTAL CRYSTAL DATA

The crystals employed in the transmitter and receiver of Radio Set AN/VRC32 and AN/FRC-42 are manufactured to General Electric specifications and differ in several essential respects from the military standard crystal types CR-#/U. Because of the difference in specifications, it cannot be expected that a system would be operable if military standard crystal types were substituted. The frequency errors resulting from the difference in conditions of application of the crystals would destroy the system performance of the units in combination. If a change of frequency or a replacement of crystal is required, a crystal designed to satisfy the special commercial specification, as noted below, must be used.

TRANSMITTER Crystal Y101 (G.E. Dwg. #A-7147191-P1)

This is an AT-cut fundamental mode crystal operating parallel resonant with a nominal load capacitance of 17 mmf. The crystal is mounted in a holder similar to the military standard holder HC-17/U. The nominal frequency range of the crystal to meet the specification is from 2 to 4.5 megacycles per second. Room temperature finishing tolerance and frequency deviation with temperature are specified separately. The finishing tolerance specification is ±.0025. Deviation with temperature may not exceed ±.002% in the range of 0°C to 90°C and .0035% in the range -30°C to +90°C. In application provision is made for trimming out the effect of all tolerances by C101 on the transmitter chassis. To assure sufficient trim range, a minimum crystal capacitance of 7.0 mmf is specified.

RECEIVER 1st Oscillator Crystal Y303 (G.E. Dwg. #B-7489151-P1)

This is an AT-cut third mode crystal operating in a parallel resonant circuit (Miller Oscillator) of an unmeasured, minimum-value input capacitance. The crystal is finished in a correlated jig. It is mounted in a holder similar to the military standard holder HC-6/U. The nominal frequency range of the crystal to meet the specification is from 21 to 51 megacycles per second. Room temperature finishing tolerance of ±800 cycles in the test jig is specified independent of the frequency deviation with temperature, which may not exceed .0025% in the range -20°C to +85°C.

RECEIVER 2nd Oscillator Crystal Y304 (G.E. Dwg. #A-7142762-P2)

This is an AT-cut fundamental mode crystal operating parallel resonant with a nominal load capacitance of 14 mmf. The crystal is mounted in a holder similar to the military standard holder HC-6/U. This is a fixed frequency unit on 3490.000 kilocycles per second. The room temperature finishing tolerance of ±100 cycles per second is specified independent of the permitted frequency deviation with temperature which may not exceed ±.005% between -30°C and +95°C. In application, provision is made for trimming an amount equal to the finishing tolerance of both the 1st and 2nd Oscillators by adjustment of capacitor C320 which is located on the Receiver chassis. To assure sufficient trim range, a minimum crystal capacitance of 11.0 mmf is specified.

INSTALLATION

GENERAL

General Electric Progress Line Mobile Combination MW13W features compact, ruggedly constructed equipment for vehicular application. This Mobile Combination is designed to provide dependable two-way radio communication with land-mobile equipment operating on fixed frequencies within the 30 to 42 megacycle range of frequencies. Each Mobile Combination consists of transmitter Model 4ET22A2, Receiver Model 4ER24B2 and Power Supply Model 4EP2G1 assembled in a 14-1/2" (width) x 14-7/8" (length) x 6-5/8" (height) drawer type case with removable cover; Control Unit Model 4EC27A1; Military Type Controlled Reluctance Microphone Model 4EM10A1; Loudspeaker Model 4EZ1A4; Antenna Base Assembly PL-7472880-G5, Spring Adaptor PL-7476632-G3 and Rod PL-7483915-G2; Fuse Box Assembly PL-7776234-G2 and the required Interconnecting Cables and Mounting Hardware.

Progress Line Mobile Combination MW13W and the units or accessories used there-in, may be employed interchangeably in 6, 12 and 24 volt vehicles. Upon initial installation, or wherever the equipment is transferred from a vehicle having one battery source (such as 6 volt) to a vehicle having another battery source (such as 12 volt), the position of the Fuse Box Assembly Cover should be checked for agreement between source designator and battery source voltage.

The Progress Line Design features built-in flexibility. Transmitter and Receiver may be used interchangeably between Mobile and Station installations operating in the same system. Rapid transfer is realized without wiring or harness problems.

This two-way radio equipment has been designed to operate in vehicles which employ battery-generator type power systems in which either the positive or negative terminal of the storage battery is grounded. To assure greater operating reliability of both equipment and vehicle, it is recommended that a heavy duty battery be installed in place of the type normally supplied. This is not an absolute necessity, but will prove worth while, particularly in colder climates. The vehicle generator charging capacity should be adequate to maintain the proper battery charge at normal driving speed.

The following tools are required for Installation Procedure

1. Electric Drill or Hand Brace
2. .1935 inch (3/16 inch or #10) drill bit
3. .3750 inch (3/8 inch) drill bit
4. .1285 inch (1/8 inch or #30) drill bit
5. .2812 inch (9/32 inch) drill bit
6. Center Punch
7. Hammer
8. Screw Driver
9. 1-5/16 inch hole saw socket punch or hole cutter
10. Hacksaw or File

Before starting the installation, plan a layout taking into account your own convenience, protection for the equipment and neatness of system units and interconnection. Suggestion for the location of units and their installation procedures are covered below.

Transmitter-Receiver

This unit may be located in the vehicle trunk compartment, on the floor of the passenger compartment, on a special platform, in a panel compartment, in a weather proof enclosure, under the seat of a truck, or in similar locations suited to the particular vehicle being equipped. The unit may be mounted horizontally or at an angle of up to 45° from the horizontal (tilting the unit to the side or back). Vertical mounting, side mounting or mounting the unit in planes up to 45° from the vertical or side mount position (tilting the unit forward, backwards or sideways) should not be made without first checking the direction of vibrator reed movement. A directional line marked on top of the vibrator indicates the direction of reed movement. This line should fall in a horizontal plane or in a plane up to 45° from the horizontal when the unit is mounted. If the unit is placed in a plane such that the mass of the vibrator reed assembly works against gravity (direction of reed movement) the expected life of the vibrator will be somewhat shortened. Two vibrators, alike in respect to specifications but differing in reed orientation, are available. In installations involving vertical mounting of the Radio Set, the A7141584-P2 vibrator is recommended. For side mount vibrator A7141584-P1 should be used to realize the expected life of the vibrator.

Procedure:

1. Remove the Transmitter-Receiver Unit chassis and the cover from the case.

2. Position the case in the pre-determined location, and mark the location of the mounting holes. If the mounting surface is less than 14 inches in depth, such as the shelf at the rear of a trunk, the front of the unit should be supported by mounting brackets (Kit ML-7147296-G1). Refer to Typical Mobile Installation Illustration. This Kit is not an Accessory but rather an option that may be purchased. In this application the brackets are to be assembled to angles using 1/4-inch bolts and elastic stop nuts. As it is desirable to keep the unit level, there are three adjustments that may be made. One adjustment is in the selection of one of four mounting holes in assembling the bracket to the angle and the case to the bracket. The second adjustment is in positioning the unit mounting stud in the correct position slot of the bracket. The third adjustment is the positioning of the angle on its mounting surface with respect to the unit (i.e. the angles may be mounted back against the shelf, so that the bracket forms a triangular section of support). Position the assembly while taking into account the above variables, so that the mounting holes in the side of the case at location "E" toward the front panel (see Installation Outline Diagram) line up with the holes or position slots of the bracket. It should not be necessary to drill holes in either the case or the metal parts of this mounting kit. 1/4-inch bolts, nuts and lockwashers, flat washers, and elastic stop nuts or wing nuts are available in the kit, for mounting the case to the bracket. The angles are to be fastened down by 1/4-inch self tapping screws furnished with the Kit.

3. Drill .1935 inch mounting holes located in the previous step, using a #10 (3/16-inch) drill. THE MOUNTING HOLES WILL NORMALLY BE IMMEDIATELY OVER THE GASOLINE TANK OR OTHER VITAL PART. CARE MUST THEREFORE BE TAKEN TO AVOID DAMAGE WHEN THE DRILL SLIPS THROUGH THE MOUNTING SURFACE.

4. Position the case so that the mounting holes line up and secure, using the 1/4-inch self tapping screws provided with the mounting hardware. When using mounting angles insert the 1/4-inch bolts from inside the case through braces, and attach wing nuts or elastic stop nuts. Level the case by positioning the bolt in the correct position slot.

5. The cover of the case may be made stationary, thereby providing a drawer type case by drilling two .098 inch holes at location "D" (see Installation Outline Diagram) with a 3/32-inch (approximate) or #40 drill, and securing with #4 sheet metal screws.

Control Unit

The Control Unit should be mounted in a location where the controls will be within convenient reach of the operator.

Usually this will be beneath the middle of the dashboard. Since the microphone cord connects to the Control Unit, the unit should be placed so that the microphone cord does not interfere with the operation of the vehicle.

Procedure:

1. Loosen the two nuts at the ends of the Control Unit, and remove the control unit mounting bracket.

2. Loosen the two screws on the back of the Control Unit until the back cover can be removed.

3. Position the mounting bracket in the pre-determined location and, using the bracket as a template, mark the two mounting holes.

4. Drill the mounting holes. When mounting the bracket on a sheet metal surface, such as a dashboard, drill the holes with a .1285 inch (#30 or 1/8-inch) drill.

5. Screw the bracket to the mounting surface. 3/4-inch #8 sheet metal screws are provided in the mounting hardware for dashboard mounting.

Do not reassemble the Control Unit until the control cable has been installed. (see CONTROL CABLES).

Loudspeaker

The Loudspeaker should be mounted in a position where it will direct the intelligence to the operator, but not where it will interfere with his vision. This will usually be on the dashboard or on the firewall.

Procedure:

1. Disassemble the swivel bracket from the speaker by removing the two nuts.

2. Using the speaker bracket as a template, locate and drill two mounting holes with a 1/8" (.1285 inch or #30) drill.

3. Mount the speaker bracket to the dashboard or firewall, using the 3/4-inch or 1-1/2 inch #8 sheet-metal screws furnished with the mounting hardware.

4. Reassemble the speaker in the bracket.

Microphone

Since the Microphone should be convenient to the operator, several positions should be considered before deciding on the permanent location. A mounting location on the front of the dashboard or on the under-lip of the dashboard near the control unit is often found satisfactory. #8 self tapping screws are supplied with the Microphone for mounting the holder.

Procedure:

1. If the microphone hanger is to be mounted on a dashboard or other sheet metal surface, use the hanger as a template to drill the mounting holes with a #30 (.1285 inch or 1/8-inch bit.)

2. Mount the hanger, using the #8 x 1/2-inch self tapping screws provided.

Antenna

In locating the low band mobile station antenna, a balance must be struck between several conflicting considerations. For one thing, the higher the antenna is mounted, the better is its radiation. On the other hand, a high antenna is more liable to damage from low hanging branches and low garage doors. An antenna mounted on the left hand side near the top of the trunk is often a satisfactory compromise. This position facilitates good radiation and at the same time minimizes the chance of damage due to low garage door, tree branches and other roadside objects. Systems will not perform satisfactorily if the antenna is not placed in accordance with good Engineering Practice.

Procedure:

To mount the antenna, first disassemble the 3-1/2 inch diameter metal plate from the base of the Antenna Base Assembly by removing the three 1/4 - 20 x 1-1/4 inch mounting screws, nuts and lockwashers and proceed as follows:

1. Use the 3-1/2 inch diameter plate as a template to locate the three mounting holes and the 1-5/16 inch center feed-through hole.

2. Use a hole saw, a socket punch or hole cutter for cutting the large center feed-through hole (1-5/16 inches in diameter).

3. Place the antenna base in position and check the alignment of the 3 mounting holes. Drill the mounting holes with a 9/32-inch (.2812 inch) drill.

4. Cut the antenna rod to length as described in the section of this text titled Antenna Length.

5. Scrape the inner surface of the body at the grounding point where contact will be made by the locknut of the metal mounting plate, to the body.

6. With the three 1/4-20 x 1-1/4 inch mounting screws, nuts and lockwashers provided, fasten the antenna base to the car, using one of the rubber gaskets on each side of the vehicle body and the metal plate over the inner gasket. Be sure to orient the rubber gasket having the two small holes so that the grounding set screws of the metal plate match the holes provided in the gaskets.

7. Loosen the nut on the 1/2-inch diameter threaded feed-through (extending inside at the center) and also the 3/8 inch - 24 x 1-1/4 inch hex socket head cap screw at the center of the ball joint. A special Allen Head wrench is supplied for adjusting the Socket Head Screw.

8. Assemble the spring to the ball and the antenna to the spring, or the antenna to the base if no spring is used.

9. Adjust the antenna base so the antenna will be vertical.

10. Tighten the 1/2-inch feed-through locking nut and the hex-socket cap screw at the center of the ball joint.

11. Adjust the set screw and locknut on the inside face of the metal plate until a good ground connection is made to the car body. An Allen Head wrench is supplied for this operation. If necessary, the set screw and antenna cable grounding screw positions can be interchanged.

12. Connect the coaxial cable to the antenna by inserting the line terminal under the screw located at the center of the feed-through stud.

13. Ground the coaxial cable shield to the base plate by inserting the shield clamp under the screw provided on the baseplate.

Antenna Length:

Progress Line Transmitters are designed for full loading into a 50-ohm transmission line having a standing wave ratio as high as 2:1. In order to obtain a minimum standing

wave ratio for the vertical whip type of antenna when the 50-ohm transmission line is used, the instruction below should be followed and the antenna cut to the length shown by graph RC166.

The graph shows the optimum length of the antenna rod plotted against the transmitter frequency. All rods are furnished seven feet in length and can be cut to the specified length with a hack saw or file.

Fuse Box Assembly

The Fuse Box Assembly requires a 6" x 10" mounting surface. It should be mounted at a point which will be close to the power source and which will allow as direct running of the power cable to the transmitter-receiver unit as possible. Choose a location where the cables will not pass close to hot surfaces or moving parts.

Procedure:

1. Remove the three screws used to fasten the cover to the assembly and remove cover.

2. Remove the two screws at the rear lip of the Fuse Mounting board and withdraw the board from the base by pulling forward.

3. Using the base as a template, drill the three mounting holes in the mounting surface with a 1/8" (.1285" or #30 drill.

4. Mount the base using the #8 x 1-1/2 inch sheet metal screws provided.

Do not reassemble the Fuse Box Assembly until the power cable has been installed and properly terminated.

Control and Power Cables

Normally the best route for the Control and Power cables to follow from the Transmitter-Receiver Unit to the Control Unit and Fuse Box Assembly is inside the vehicle, under the floor mats, along side the drive shift channel. This makes a neat installation and protects the cable from weather and abrasion. Avoid laying the cable near moving parts, sharp edges or hot surfaces, as these tend to shorten the life of the cables. Leave enough cable slack at the transmitter-receiver unit to permit removal of the unit from its case for servicing. It may be necessary to drill or cut feed-through holes in separating partitions to allow passage of power and control cables.

Procedure:

1. Connect the Control Cable to the 21-pin connector and the Power Cable to the 10-pin connector on the front of the transmitter-receiver. Run the Control Cable to the Control Unit and the Power Cable to the Fuse Box Assembly. Cable cleats and sheet metal screws for mounting them are supplied for use where needed. Holes for the cable cleat screws should be drilled with a 1/8" (.1285 inch or #30) drill.

NOTE

The Power Cable is 18 feet in length. TO REALIZE MAXIMUM OPERATING EFFICIENCY, DO NOT REDUCE THIS LENGTH OR USE OTHER THAN THE SPECIFIED CABLE.

2. Run the terminal ends of the Control Cable through the oblong hole in the cover of the Control Unit. The stay hook, which is clamped to the cable, should also be slipped through this hole so that it may be hooked into one of the stay holes along side the oblong hole, after connections are made.

3. Connect the pin plugs of the Control Cable wires grouped together by "J702" band, to the receptacle J702 inside the Control Unit according to the wire marker numbers. Similarly connect the "J703" wires to J703 and the "J704" wires to J704. Note that the marker numbers indicate the number of the pin receptacle into which the pin plug is to be inserted.

4. Connect the Power Cable wires to the 1/4" studs on the underside of the Fuse Box Assembly Fuse Board. To aid in this operation, wire markers are wrapped around the wires at the lug ends. The numbers printed on the wire markers should correspond to the numbers stamped under the studs, when the wires are correctly terminated.

5. Reassemble the Fuse Mounting Board to the Fuse Box Assembly Base.

NOTE

A slot has been formed in the side lip of the cover at center position, below the indicator window, as a means of insuring correct placement of cover during service. Holes have been tapped in 3 sides of the base (below source indicator strips) at positions to match the slot location of the cover. The 8-32 x 5/16 inch screw with 1/8" spacer (assembled to the side of the base below the 12 V indicator strip) should

be assembled in the tapped hole below the source indicator corresponding to the source voltage being utilized.

6. Plug in the Fuse Box Assembly cover. Notice the Power Source Indicator Window, adjacent to the handle of the cover. This Fuse Box Assembly has been designed for 6, 12 and 24 volt applications. When correctly assembled, the system power source being utilized (6, 12 or 24 volt), should be seen through the indicator window. Secure using the three cover retaining screws.

7. Run the brown wire from the Control Unit to the Fuse Box Assembly. Cut to length, attach stake on lug and connect to empty stud on the Fuse Box Assembly Cover.

8. Use the unlabeled four foot #4 wire attached to the Fuse Box Assembly Cover and connect to the "hot" side of the battery. This connection will usually be made to the starter terminal.

9. Ground the remaining #4 wire (labeled "GND") attached to the Fuse Box Assembly Cover (preferably battery ground or engine block).

Loudspeaker Cable

Pass the Loudspeaker lead through the Control Cable hole in the back cover of the Control Unit and plug the two pins into the "SPKR" pin receptacles of Jack J703. Re-assemble the Control Unit and assemble to mounting bracket.

Microphone Cord

Connect the Microphone Cord to J701 located on the front of the Control Unit.

Antenna Cable

Connect the antenna coaxial cable to the Antenna Input jack on the front of the Transmitter Receiver Unit.

NOISE SUPPRESSION

Some sort of noise suppression is necessary in practically every vehicle. The extent to which the suppression must be carried out depends largely upon the minimum signal strength found in the service area. If the signal strength found in the service area is high, noise suppression may not be necessary.

The material in the Suppressor Kit supplied with mobile combinations include 12 inches of bonding braid, one 10,000 cable type suppressor and two 0.5 MF metal shielded paper by-pass capacitors.

Installation Procedure:

1. The 12 inches of bonding braid is supplied for electrically bonding any metallic parts of the vehicle which are in loose contact with one another and not bonded by the manufacturer of the vehicle. Differences in potential of two metallic surfaces will cause noise to be generated when these parts touch. Possible trouble points causing this type of noise include the hood, muffler and exhaust pipe, motor block, doors and rear axle assembly.

2. The cable type suppressor should be installed in the high tension lead to the center tower of the distributor. To install suppressor, remove the lead from the center tower of the distributor. Cut lead at the distributor end. Screw the cut ends of the lead into the suppressor. Reinsert the lead into the center tower of the distributor.

3. Two by-pass capacitors are provided for application to Generator and Fuel or Oil gauge. To install, mount the capacitor under a screw providing good grounding (scrape surface) and attach lead to by-pass point. To by-pass the generator output, connect the capacitor lead to the armature. DO NOT BYPASS THE FIELD TERMINAL AS DAMAGE WILL RESULT. By-pass the battery lead to the fuel gauge, oil gauge, or any other dash instrument or accessory that is producing noise, with the remaining capacitor.

SYSTEM ADJUSTMENT, OPERATION AND MAINTENANCE

After the system has been installed, there are a few checks and system adjustments required before placing the transmitter-receiver in service. DO NOT TRY TO TOUCH-UP TUNING CONTROLS AFFECTING THE ALIGNMENT OF THE UNITS, as each unit has been factory aligned to 40.82 megacycles before shipment. Operation will only be degraded if touch-up is attempted. Complete ALIGNMENT PROCEDURES are included in the Instruction Book if evidence of misalignment is present or realignment is required.

ADJUSTMENT

TOOLS REQUIRED

1. A tuning tool and screw driver.

2. A 20,000 ohm-per-volt meter which covers the 0-3 volt range (G-E Test Set Type EX-1-C, G-E Shock Resistant Test Meter Type EX-2-B or equivalent 20,000 ohm-per-volt meter).

3. Access to a transmitter signal on the system frequency, for receiver adjustment.

TRANSMITTER PROCEDURE

The transmitter was factory aligned on 40.82 megacycles. If the System Operating frequency is 40.82 megacycles, the procedure given below is all that will be required for the transmitter installation adjustment. To align the transmitter on a frequency other than 40.82 megacycles, follow the Bench Alignment Procedure (Page 2-9 through Page 2-12) excluding Modulation Adjustment.

1. Connect the antenna or suitable load to the Antenna Input, jack, J111. Check to be sure the proper crystal is plugged between pins 4 and 6 of crystal socket XY101. To calculate the crystal frequency divide the system operating frequency by 12.

2. Place the TUNE-OPERATE switch in the TUNE position.

3. Rotate the ANT COUPLING control to the extreme counter clockwise position (uncoupled).

4. Turn power on and allow 30 seconds for warm-up.

5. Check for drive of at least 1.5 volts at the PA GRID jack (green-negative). If necessary, repeak Ƶ 114 ("5") and Ƶ 117 ("6").

6. Plug the positive meter probe into the CATH PA jack and the negative meter probe in the GND jack on the Power Supply Chassis.

7. Key the transmitter and tune the PA PLATE tuning control for a minimum (dip).

8. Place TUNE-OPERATE switch in OPERATE position.

9. Key transmitter and re-dip PA PLATE tuning controls. The neon lamp should be a minimum brightness.

10. Rotate ANT COUPLING control slightly (10^{o}or so) clockwise. Do not over couple or false setting will be obtained.

11. Key transmitter and adjust ANT TUNING control for maximum brightness of neon lamp.

12. Key transmitter and adjust ANT COUPLING control clockwise for reading of 1.5 volts* at CATH PA jack or maximum brightness of neon lamp, whichever is arrived at first.

13. Repeat steps 11 and 12.

NOTE

For FCC purposes, the plate current of the power amplifier stage may be accurately calculated in milliamperes by multiplying the reading at the CATH PA jack by 100.

RECEIVER PROCEDURE

The Receiver was factory aligned for an operating frequency of 40.82 megacycles. If the System Operating frequency is 40.82 megacycles, the procedure given below is all that will be required for the Receiver Installation Adjustment. When changing the operating frequency of the Receiver follow the FRONT END TUNING procedures (page 3-19 through page 3-22) of the RECEIVER BENCH ALIGNMENT PROCEDURE and then the procedure given below. For frequencies between 30 megacycles, and 38 megacycles, solder in a link to ground T314-C2 and T314-C8.

1. Connect the antenna to the Antenna Input jack, J111. Check the frequency of the First Oscillator crystal. This

frequency may be calculated by subtracting 3.2 megacycles from the System Operating frequency.

2. Plug the negative probe of the tuning meter in the LIM-1 jack and the positive probe in the GND jack on the power supply chassis.

3. While receiving a weak (LIM-1 reads below limiting) unmodulated signal on the system frequency (exact frequency of transmitter to be monitored), peak the Antenna Transformer (T314) preselector circuit trimmer C1 on top of transformer and trimmer C3 on bottom of transformer.

4. Remove negative probe from LIM-1 jack and insert in DISC jack.

5. While receiving a strong, unmodulated signal on the system frequency (exact frequency of transmitter to be monitored), note the meter reading. If the discriminator meter reads more than 0.2 volts (EX-2-B Meter) or 1.0 volt (VTVM) and the transmitter is known to be on frequency, adjust the OSC-2 trimmer (C320) for Zero discriminator reading.

6. Under no carrier condition, rotate the SQUELCH control on the Control Unit fully clockwise, or until noise is heard in the loudspeaker, then rotate counterclockwise until the noise just disappears. (For general use, turn the control approximately 15^{o} past the point where the noise just disappears).

7. While monitoring a modulated signal, adjust the VOLUME control on the Control Unit for the desired listening level.

OPERATION

THE TRANSMITTER ADJUSTMENT SHOULD BE MADE BEFORE ATTEMPTING OPERATION OF A SYSTEM.

Power may be applied to the unit by turning the mobile control unit power switch ON. THE VEHICLE ENGINE SHOULD BE RUNNING BEFORE THE EQUIPMENT IS TURNED ON. IF THE BATTERY VOLTAGE IS LOW AND THE STARTER BUTTON IS PRESSED, THERE IS A HEAVY CURRENT DRAIN OF THE STARTER MOTOR. THE BATTERY VOLTAGE MAY DROP TO A POINT WHERE THE VIBRATOR CEASES TO VIBRATE WHICH COULD CAUSE THE PRIMARY CONTACTS TO ARC AND DAMAGE THE VIBRATOR.

Closing the ON-OFF switch will apply the "A" voltage to the coil of the power relay. The contacts of this relay transfer "A" power to the filaments and Power Supply. The green pilot on the control unit will be illuminated when the "A" voltage is supplied to the units. This light remains glowing all the time the equipment is ON and indicates stand-by condition. The red pilot light on the Control Unit will be turned on when the transmitter is On-the-Air. When the microphone or handset push-to-talk button is depressed, plate voltage is applied to the transmitter, the red pilot light glows, the transmitter carrier is radiated and the loudspeaker is muted. Upon release of the PTT button, the receiver becomes operative and the red pilot light goes off. The two adjustable controls marked VOLUME and SQUELCH should be adjusted upon installation. The VOLUME control raises or lowers the sound level as heard from the loudspeaker or handset ear piece. The SQUELCH control setting is a critical adjustment for efficient operation. Essentially its function is to mute the loudspeaker while no signals are received.

MICROPHONE TECHNIQUE

Misuse of the microphone is probably the greatest single reason for so called "poor transmission performance". Some attention should, therefore, be given to the proper use of the microphone. If the operator speaks distinctly, in a normal voice, directly into the microphone the message can be easily understood. It is to the operator's advantage to try a few calls and through practice and constructive criticism at the receiving end, develope a microphone technique that is best suited to his characteristics of speech.

MAINTENANCE

1. To insure good electrical continuity and high operating efficiency, routine checks should be made of all mechanical and electrical connections and parts. Battery and equipment connections to the voltage source should be periodically checked for tightness. Loose or poor connections to the power source will cause excessive voltage drops and faulty operation may ensue. The vehicle generator and generator regulator should be maintained regularly to keep the generating system within safe and economical operating limits. The vehicle regulator is the basis of control and should automatically limit the charging circuit from exceeding predetermined values. If generator voltage is excessive, tubes, lights, etc. may burn out prematurely. This condition is indicated when the battery loses water rapidly. Usage of 1 or 2 ounces of water per cell per week is acceptable for batteries in continuous operation.

2. Any deposit of corrosion, grease or extraneous matter should be removed by an appropriate solvent*.

3. Since mobile units are subject to constant shock and vibration, it is advisable to check for loose plugs, nuts, screws and parts to make sure that nothing is working loose.

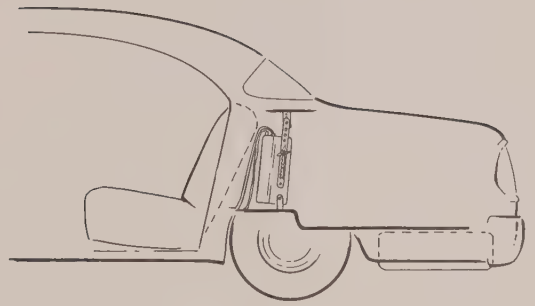
4. Examine the contacts of the relays. Where relay contacts carry little or no current, the contacts do not clean themselves and an insulating coating is apt to form. Current carrying contacts are subject to pitting and should be burnished from time to time. When contacts become coated, remove the film with a suitable solvent* applied with a non-metallic brush, such as a tooth brush. Dust and particles should be removed by a clean, dry, non-metallic brush. When contacts are pitted they should be burnished to smooth out any metallic deposits. A burnishing tool, such as a piece of smooth sandblasted clock spring steel, should be used for this purpose.

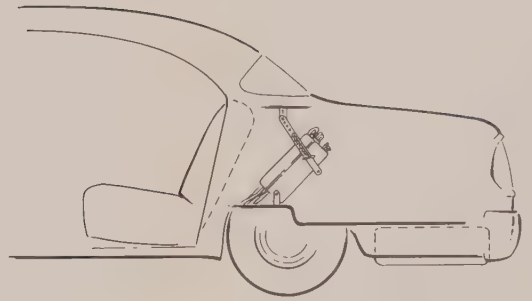
5. The antenna, antenna base and all contacts should be kept clean and free from dirt or corrosion. If the antenna or its base is covered with an insulating coat or is poorly grounded, loss of radiation and a weak signal will result.

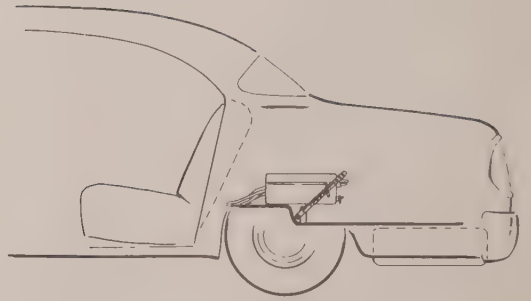
Refer to the unit Description and Maintenance instruction for regular maintenance information suggested for care of the individual units.

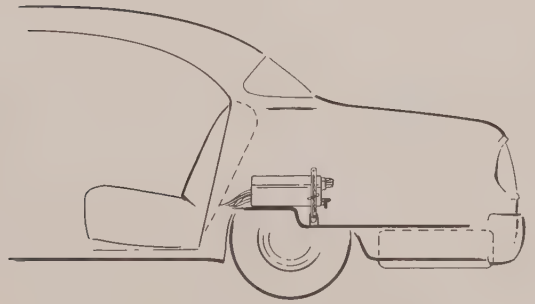
---

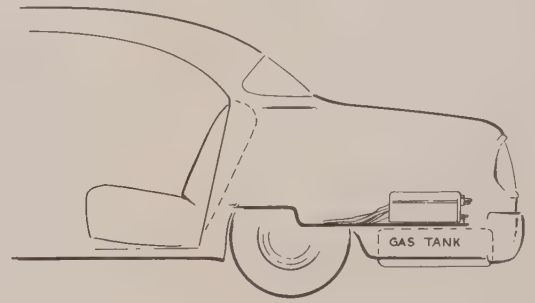
* It is recommended that Navy personnel use Dry Cleaning Solvent 140F SNSN G51-S-47180.

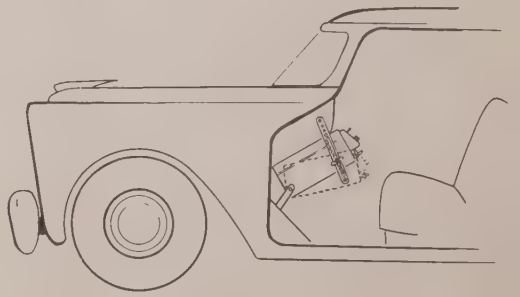






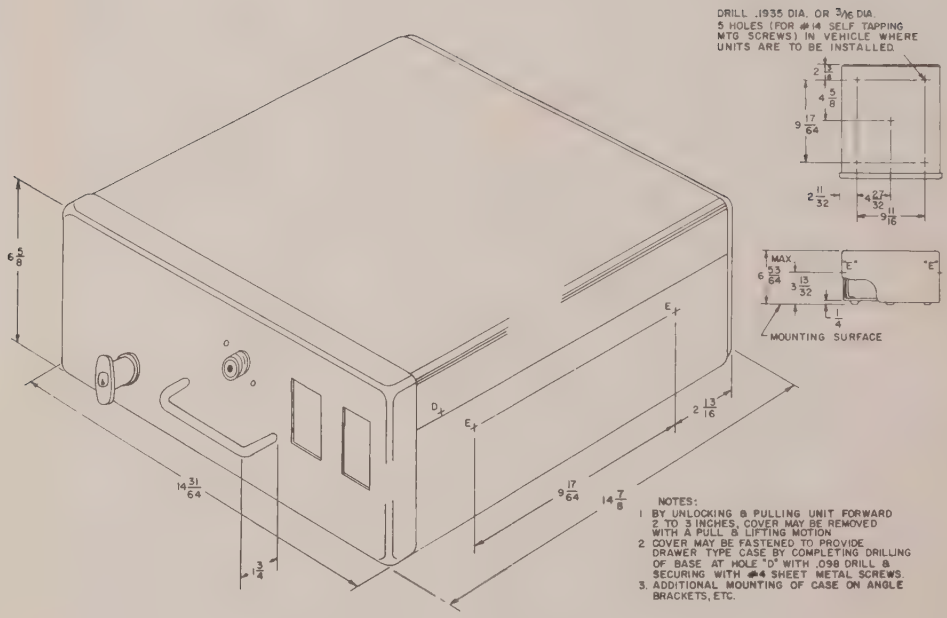






TYPICAL MOBILE INSTALLATIONS

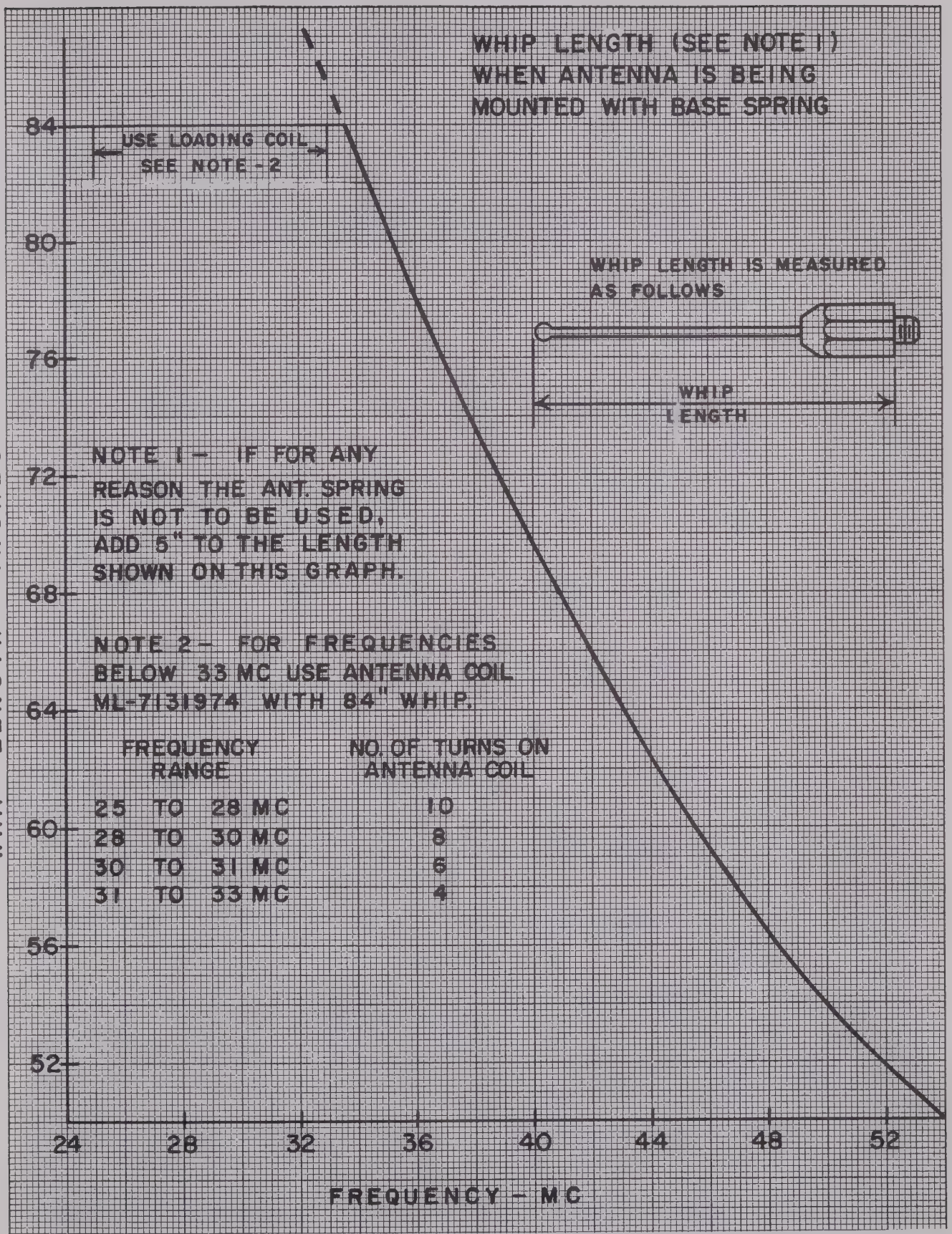
(RC-361)


DRILL .1935 DIA. OR 3/16 DIA.
5 HOLES (FOR #14 SELF TAPPING MTG SCREWS) IN VEHICLE WHERE UNITS ARE TO BE INSTALLED.
2 13/32
4 5/8
9 17/64
2 11/32
4 27/32
9 11/16
MAX.
6 23/64
3 13/32
1/4
MOUNTING SURFACE
6 5/8
14 31/64
3/4
D
E
9 17/64
14 7/8
2 13/16
NOTES:
1 BY UNLOCKING & PULLING UNIT FORWARD 2 TO 3 INCHES, COVER MAY BE REMOVED WITH A PULL & LIFTING MOTION
2 COVER MAY BE FASTENED TO PROVIDE DRAWER TYPE CASE BY COMPLETING DRILLING OF BASE AT HOLE "D" WITH .098 DRILL & SECURING WITH #4 SHEET METAL SCREWS.
3. ADDITIONAL MOUNTING OF CASE ON ANGLE BRACKETS, ETC.

Installation Outline Diagram

TRANSMITTER-RECEIVER POWER SUPPLY UNIT

(C-7776322, Rev. 0)



ANTENNA LENGTHS USING
RG-8/U COAXIAL CABLE

A 7135401

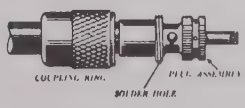
TITLE INSTRUCTIONS

FOR ASSEMBLY OF 83 SERIES, TYPE UHF PLUGS

ASSEMBLY OF CABLES TO 83-1SP PLUG

Cut end of cable even.
Remove vinyl jacket 1⅛"—*don't nick braid.*

Bare ¾" of center conductor—*don't nick conductor.*
Trim braided shield 1/16" and trim.
Slide coupling ring on cable.

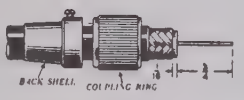


Screw the plug assembly on cable.
Solder assembly to braid thru solder holes.
Solder conductor to contact sleeve.

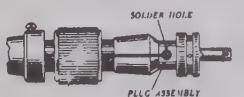
Screw coupling ring on assembly.

ASSEMBLY OF CABLES TO 83-1SPN PLUG

Cut end of cable even.
Remove vinyl jacket 1⅛"—*don't nick braid.*



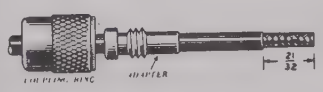
Bare ¾" of center conductor—*don't nick conductor.*
Trim braided shield 1/16" and tin.
Slide back shell and coupling ring on cable.



Screw the plug assembly on cable.
Solder plug assembly to braid thru solder holes.
Solder conductor to contact sleeve.

Position coupling ring and back shell.
Tighten set screw.

ASSEMBLY OF CABLES TO 83-1SP PLUG USING ADAPTERS 83-168 AND 83-185



Cut end of cable even.
Remove vinyl jacket 21/32"—*don't nick braid.*
Slide coupling ring and adapter on cable.

Fan braid slightly and fold back over cable.

Compress braid around cable.
Position adapter to dimension shown.
Press braid down over body of adapter and trim.

Bare ½" of center conductor—*don't nick conductor.*
Pre-tin exposed center conductor.

Screw the plug assembly on adapter.
Solder braid to shell thru solder holes.
Solder conductor to contact sleeve.

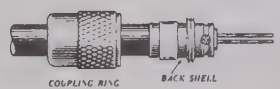
Screw coupling ring on back shell.

ASSEMBLY OF TWINAX TO 83-22SP PLUG

Plugs 83-2SP and 83-21SP are assembled as shown except remove vinyl jacket 1¼".

Cut end of cable even.
Remove vinyl jacket 1⅛"—*don't nick braid.*

Bare ¾" of conductors—*don't nick conductors.*
Trim braided shield 1/16" and tin.



Slide coupling ring on cable.
Screw back shell on cable—see that solder hole lines up with conductor as shown.

Assemble front shell to back shell.
If assembled properly, the solder holes in both front shell and back shell will line up.

Solder braid to shells thru solder holes.
Solder conductors to contact sleeves.

Screw coupling ring on back shell.

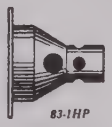
A 7135402

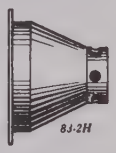
TITLE INSTRUCTIONS

ASSEMBLY OF 83 SERIES, UHF RECEPTACLES USING HOODS

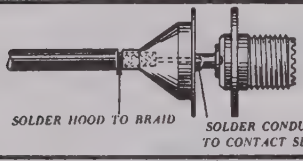
83-76S

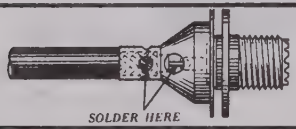
83-1H

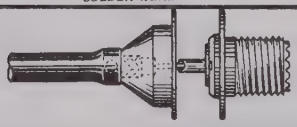

83-1HP


83-2H

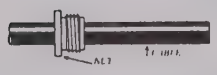
	83-76S	83-1H	83-1HP	83-2H
Cut end of cable even. Remove vinyl jacket. . . . . *Do not nick braid.*	3/4"	5/8"	3/4"	3/4"
Remove braid and dielectric to expose center conductor. . . . . *Do not nick conductor.*	5/16"	5/16"	5/16"	5/16"
Fan braided shielding.				
Smooth out shielding. Trim braid to size. . . . . Tin braid and wipe clean. Soldering and assembly depends on the hood used, as illustrated.	3/8"	3/16	3/8"	3/16
Slide hood over braid. Solder conductor to contact. Slide hood flush against receptacle and bolt both to chassis. Solder hood to braid as illustrated. . . . . Tape this junction if necessary.	Yes	No	No	No
Slide hood over braid. Bring receptacle flush against hood. Solder hood to braid and conductor to contact sleeve thru solder holes as illustrated. . . . . Tape junction if necessary.	No	No	Yes	No
Slide hood over braid and force under vinyl. Place inner conductor in contact sleeve and solder. Push hood flush against receptacle. Solder hood to braid through solder holes. . . . . Tape junction if necessary.	No	Yes	No	Yes







ASSEMBLY INSTRUCTIONS FOR TYPE BNC CONNECTORS



Cut end of cable even.

Remove vinyl jacket ½" — *don't nick braid.*

Push braid back, and remove ⅛" of insulation and conductor.

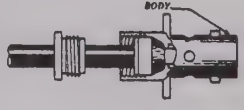
Taper braid.

Slide sleeve over tapered braid. Fit inner shoulder of sleeve squarely against end of jacket.

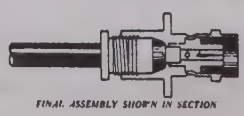
With sleeve in place, comb out braid, fold back smooth as shown, and trim 3/32"

Bare center conductor ⅛" — *don't nick conductor.*

Tin center conductor of cable. Slip female contact in place and solder. Remove excess solder. *Be sure cable dielectric is not heated excessively and swollen so as to prevent dielectric entering body.*

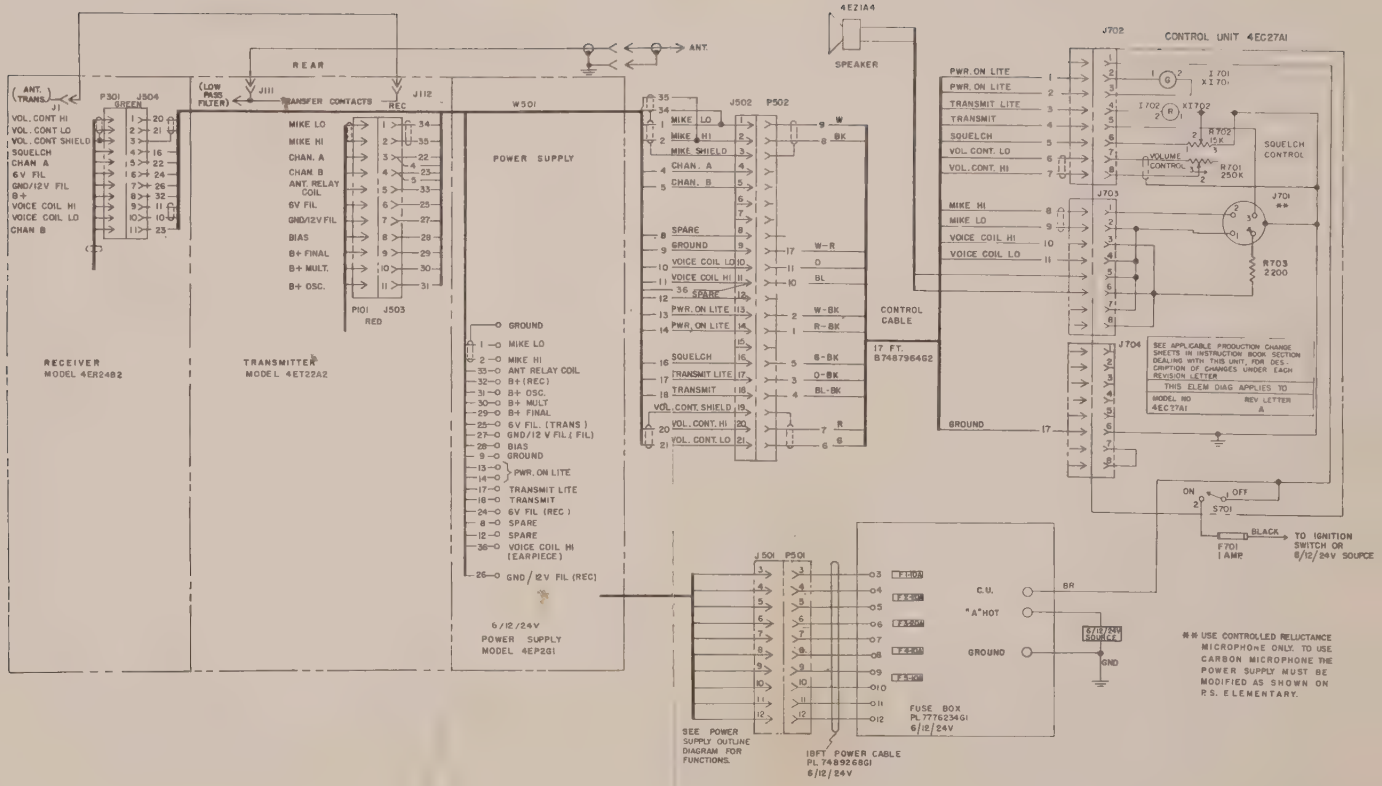


Push into body as far as it will go. Slide nut into body and screw into place, with wrench, until moderately tight. Hold cable and shell rigidly and rotate nut.



FINAL ASSEMBLY SHOWN IN SECTION

This assembly procedure applies to BNC jacks. The assembly for plugs is the same except for the use of male contacts and a plug body.



Interconnection diagram

MOBILE COMBINATION MW 13W

(D-7669479, Rev. 1)

2-WAY MOBILE RADIO

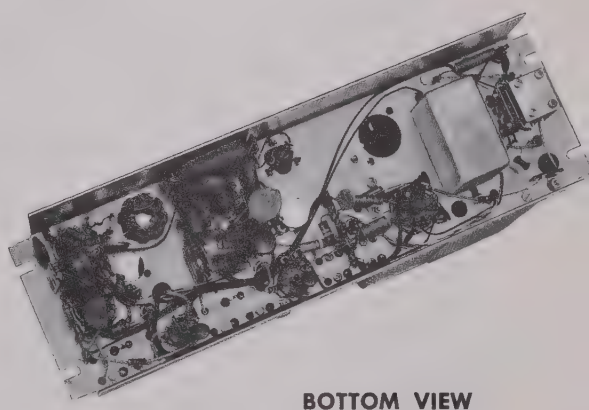
THE PROGRESS LINE

CHASSIS T-13

COMMUNICATION EQUIPMENT

Type	ET-22-A transmitter for mobile or station use.
Frequency range	Model No. 4ET22A1: 25-30 megacycles Model No. 4ET22A2: 30-42 megacycles Model No. 4ET22A3: 40-54 megacycles
Power output at rated voltage:	
INPUT VOLTAGE:	USED WITH POWER SUPPLY — POWER OUTPUT: 25-54 MC
117 volts a-c	PA-3 — 30 watts ±10%
6.3 volts d-c OR 12.9 volts d-c	PV-3 — 30 watts ±10% PD-3 — 30 watts ±10%
Tube complement	6661/6BH6 oscillator. 6U8 modulator (triode section) 1st multiplier (pentode section) 6661/6BH6 2nd multiplier 6CL6 3rd multiplier 6146 power amplifier 12AU7 audio amplifier 12AU7 modulation limiter
Modulation	WIDE BAND: ±15 kc swing with instantaneous modulation limiting NARROW BAND: ±5 kc swing with instantaneous modulation limiting
Crystal multiplication factor	12
Ambient Temperature (Outside of cabinet which houses chassis)	− 30°C to + 60°C
Frequency stability over specified temperature range	Unheated crystal: ±0.002% Heated crystal: ± 0.0005%
Audio frequency characteristics	Between + 1 to − 3 db of a 6 db/octave pre-emphasis from 300 to 3000 cps. reference 1000 cps.
Spurious and harmonic radiation	At least 80 db below rated power output at any frequency.
Rated duty cycle	Intermittent duty
Hum and noise level below ± 10 kc swing	− 40 db
Maximum recommended channel separation in 2, 3 or 4 frequency operation	0.4% of operating frequency (approximately 160 kc)
Size	6" high x 4" wide x 13½" long
Weight	3½ lbs.

TOP VIEW



BOTTOM VIEW

The equipment described above meets or exceeds all applicable RETMA specifications. Technical data is on file with, and the equipment is acceptable for licensing by, the FCC.

SCOPE OF SPECIFICATION—In the construction of the equipment described herein, the full intent of the specification will be met. It is assumed, however, that any departure from the specification, desirable for reasons of improved design or operation, will be permissible.

GENERAL ELECTRIC

DESCRIPTION AND MAINTENANCE INSTRUCTIONS FOR TRANSMITTER MODEL 4ET22A2

General Electric Transmitter Model 4ET22A2 is a Progress Line unit designed for operation on fixed frequencies within the 30 to 42 megacycle band. Through the use of plug and cable connections each transmitter has been made readily interchangeable between mobile and fixed stations. A screwdriver is the only tool needed to make the change.

The crystal-controlled, phase-modulated transmitter employs a total of seven tubes, two of which comprise the audio section and the remainder the RF section. The transmitter's quartz crystal carries a LIFETIME GUARANTEE.

The transmitter has been designed for maximum accessibility of tuning controls and components. All tubes and tuning controls are accessible from the top of the chassis. No voltages are exposed above the chassis. All power and control connections to the transmitter are made through an 11-pin plug and cable (W101) to the power supply.

An RF Indicator (I101) is provided on the transmitter chassis to indicate the presence of RF voltage on the antenna lead. It may also be used as an auxiliary means of tuning the PA and its drive and the antenna circuit for maximum power to the antenna. Servicing is further simplified by using the Indicator to locate such faults as an open antenna circuit.

TUBES

The tubes employed in the transmitter are widely accepted, highly efficient, long-life tubes which meet the requirements of the majority of installations. As Communication Type Tubes become available, they are being incorporated in the transmitter in place of the standard tube types. Communication Type Tubes are pre-tested tubes selected specifically to meet the requirements of two-way applications. Communication type tubes, are tested for heater cycling reliability, operation at ± 20% of filament ratings and stabilized for a pre-determined period of time.

In certain mobile installations, where heavy shock and vibration are regularly encountered, still more rugged tubes, the G-E Five Star Tubes, may prove more economical. Five-Star Tubes are more ruggedly constructed, must pass more rigid tests, and are carefully "aged" before packaging. This results in

greatly increased life, particularly under the severe vibration and shock conditions sometimes encountered in mobile installations. The Communication Type Tubes and Five-Star Tubes which are available for use in the transmitter are listed below. Check with your tube supplier, regarding the availability of these tubes marked with an asterisk.

Standard Tube Type	Communication Tube Type	Five-Star Tube Type
6BH6	6661	GL-6265
12AU7	*	GL-5814-A

No modification of the transmitter is required when substituting Communication Tubes for any of their prototypes in the transmitter or when replacing all of the 6BH6's and 12AU7's in the transmitter with Five-Star Tubes. If only part of the 6BH6's and 12AU7's are replaced by Five-Star Tubes, it may be necessary to add a filament-balancing resistor if the transmitter is employed in 12-volt installations.

MAINTENANCE

To obtain optimum performance from the transmitter, a program of regular preventive maintenance should be followed. This preventive maintenance should include the following:

1. A check of the operating frequency as required by the Federal Communication Commission.

2. Comparison of voltages read at the metering jacks with those given on the back of the SERVICE OUTLINE for the transmitter.

3. A check of the power amplifier tank tuning and realignment if improper operation is indicated.

4. Inspection for loose screws and nuts or broken cables and wires caused by shock or vibration in mobile units.

5. Measurement of the B-plus voltages on the power supply chassis.

6. Preventive maintenance on the battery, generator and voltage regulator when installed in a vehicle.

7. Cleaning of relay contacts when necessary.

CIRCUIT ANALYSIS

Transmitter Model 4ET22A2 is a crystal-controlled, phase-modulated transmitter having a nominal power output of 30 watts. The crystals used fall in the range from 2.50 to 3.50 megacycles. The multiplier stages multiply the crystal frequency 12 times.

CRYSTAL OSCILLATOR

Keying the transmitter applies B-plus voltage to the crystal oscillator, V101 (6BH6). The oscillator is of the electron-coupled type and uses a capacitive voltage-divider feedback network consisting of C102 and the input capacitance of V101 to maintain oscillation. Heated ovens are available for maintaining the crystal temperature at 110°C (230°F), stabilizing the frequency against drift due to temperature change. The cathode circuit of V101 is continuously grounded.

AUDIO AMPLIFIER, LIMITER AND MODULATOR

Audio voltage from the microphone is developed across resistor R165 and applied to the grid of the first half of audio amplifier V110 (12AU7), which operates as a flat amplifier (see Fig. 1). Signal B represents an audio signal that is at a higher level than signal A.

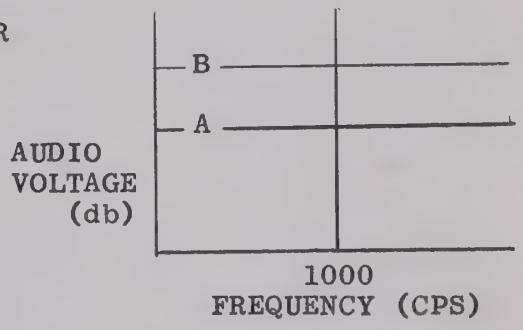


Fig. 1 - Audio Amp-1 Output

The output of the first audio amplifier is coupled to the grid of the second audio amplifier by C174, which, along with R174, provides 6 db per octave preemphasis of the audio signal (see Fig. 2). Notice the small capacitance of C174, which allows high audio frequencies to pass more easily than low frequencies to the grid of the second audio amplifier.

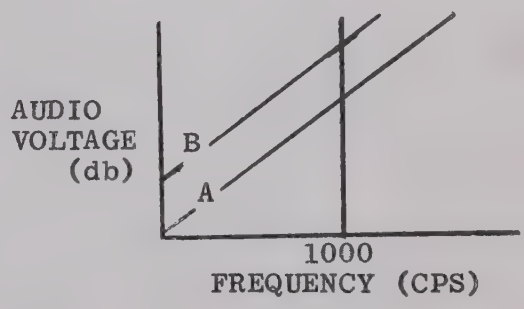


Fig. 2 - Audio Amp-2 Output

Since the first half of limiter tube V109 (12AU7) is operating with relatively low plate voltage, negative peaks above a certain fixed level are clipped. Because of the relatively low grid bias on the second half of the limiter tube, the positive peaks are also clipped. If the audio input to the transmitter is not great enough to cause limiting, V109 acts as a simple audio amplifier. Notice that, with equal input levels, the high-frequency signals are limited first (see Fig. 3).

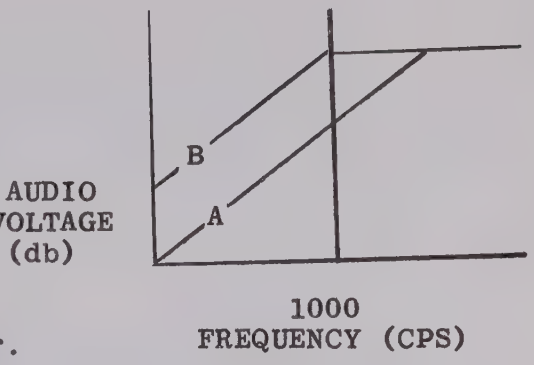


Fig. 3 - Limiter Output

MOD potentiometer R186 controls the modulation level. In order to eliminate the effect of the preemphasis circuit on signals which are below limiting, a deemphasis network, composed of R187 and C184, is employed. Therefore, below limiting, the audio response is flat, as at the input. Notice that low-level signals are limited at higher frequencies than high-level signals.

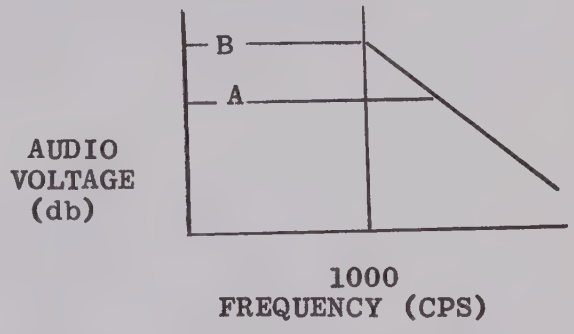


Fig. 4 - Modulating Signal

The audio modulation shown in Fig. 4 produces proportional phase modulation in V102 (6U8), as shown in Fig. 5.

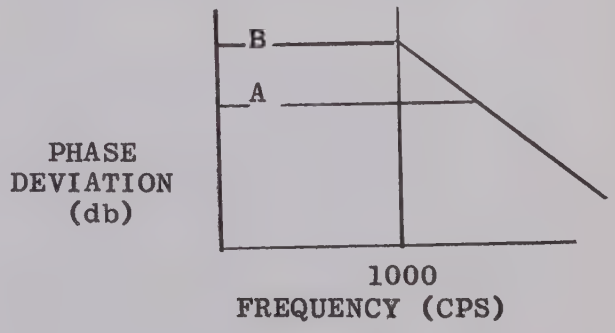


Fig. 5 - Phase Modulation

When considered as frequency modulation, phase modulation is automatically preemphasized (see Fig. 6). Notice that no signal can exceed a 15-kilocycle swing, as controlled by the limiter and the MOD control.

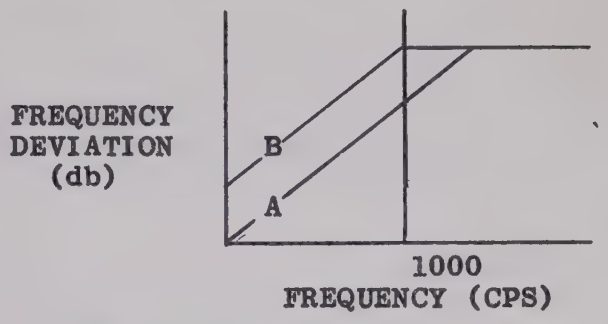


Fig. 6 - Frequency Modulation

A deemphasis circuit is provided in the receiver to compensate for the pre-emphasis of the FM signal, giving flat audio response below limiting and de-emphasized response beyond clipping (Fig. 7).

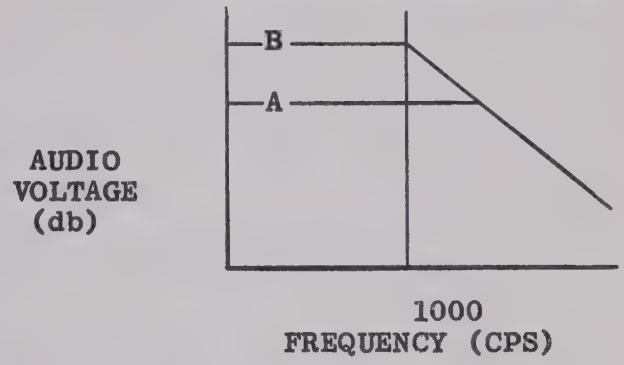


Fig. 7 - Receiver Response

The RF output of the oscillator stage which is developed across L101, is applied to the input of the phase modulator, the triode section of V102. When an audio modulating voltage from the output of the deemphasis network is also applied to the input of the modulator, the resulting modulator output is a phase-modulated RF signal (indirect FM), which is applied to the first multiplier, the pentode section of V102.

MULTIPLIERS

The first multipler is a frequency doubler, whose grid bias is self-developed across R115 and R116. The MULT-1 metering jack is provided to observe the operation of the oscillator and modulator stages. The tank circuit Z102 is tuned to twice the crystal frequency by adjustment of the tuning slug in the coil. The output of the first multiplier is capacitively coupled to the grid tank Z105 of the second multiplier.

The second multiplier, V103 (6BH6), is a frequency tripler. Z105-R1 and R121 are MULT-2 metering resistors for tuning the first multiplier plate and the second multiplier grid. The second multiplier plate tank Z108 is tuned to six times the crystal frequency and is capacitively coupled to the third multiplier grid tank Z111.

The third multiplier, V104 (6CL6), is a doubler. The MULT-3 jack is used in tuning the second multiplier plate tank coil Z108 and the third multiplier grid tank coil Z111. The third multiplier plate tank Z114 is tuned to twelve times the crystal frequency and is coupled to the power amplifier grid tank (Z117) by means of capacitive coupling.

POWER AMPLIFIER

Transmitter Models 4ET22A2 employs a single 6146 power amplifier tube, V105, to obtain a nominal power output of 30 watts. Fixed bias is permanently applied to the grid of the power amplifier as a protective measure. Consequently, there is a small residual meter reading at the PA GRID jack, even when no excitation is present. A TUNE-OPERATE switch, S101, is provided to reduce the screen voltage on the 6146 power amplifier tube while the transmitter is being tuned, for protection against excessive plate current.

The plate tank coil is a shunt-fed, parallel-resonant circuit with the PA PLATE control at ground potential. The choke in the PA plate Z123, is used to eliminate any oscillation above the operating frequency, while the grid return connection to XV105-8 serves to neutralize the PA tubes at the operating frequency. The amount of inductive coupling between L105 and L111, the antenna coil, may be adjusted by means of the ANT COUPLING control, which varies the orientation of L111 with respect to L105. The ANT TUNING capacitor, C139, is used to tune out any reactance presented to the antenna circuit by an antenna feed cable having a standing-wave ratio greater than 1:1, a situation nearly always encountered in actual installations.

LOW-PASS FILTER, ANTENNA RELAY AND RF INDICATOR

Following the antenna coupling coil is a low-pass filter consisting of one constant-K and two M-derived half sections. Keying the transmitter energizes the antenna relay, K101, which switches the antenna from the receiver to the transmitter. The RF indicator, I101, is a neon lamp used to indicate the tuning of the antenna and the voltage on the PA screen.

BENCH ALIGNMENT PROCEDURE
FOR
TRANSMITTER MODEL 4ET22A2

This Bench Alignment Procedure is provided for completely realigning Transmitter Model 4ET22A2 or for changing frequency. Instructions for adjusting the modulation level are included.

Test Equipment

The transmitter can be completely realigned, using a 20,000 ohm-per-volt voltmeter which covers the 0 to 3-volt range. The voltage indications given in the following alignment procedure are the values which should be read on such a meter. General Electric Test Set Type EX-1-C is an instrument designed for the many metering applications encountered when tuning Radio Communication and associated equipment and includes a 20,000 ohm-per-volt meter.

If a meter equivalent to the one suggested is not available for tuning purposes, others may be used; but the meter reading obtained must be corrected to account for the shunting effect of the different meter resistance on the metering circuit.

The following test equipment is recommended:

1. A 20,000 ohm-per-volt meter, such as the G-E Test Set Type EX-1-C, which covers the 0 to 3-volt range.

2. A non-metallic screwdriver.

3. A frequency measuring device.

4. An absorption wavemeter which will tune to 2, 6 and 12 times the crystal frequency.

Procedure

Refer to SERVICE OUTLINE, Page 2-25 to locate the tuning controls referred to in the following alignment procedure. All meter readings are measured between the jack indicated and ground.

1. Be sure that the crystal is connected between pins 4 and 6 of crystal socket XY101.

2. Connect the antenna or some other suitable 50-ohm load to the ANT jack.

3. Set the TUNE-OPERATE switch (S101 on the PA housing) on TUNE.

4. Rotate the ANT COUPLING control to its extreme counter-clockwise position.

5. Turn the power on and allow 30 seconds for the transmitter to warm up to operating temperature.

6. A voltage reading greater than 1.0 volt between the MULT-1 jack, J101 (green-negative), and ground when the transmitter is keyed indicates proper operation of the Oscillator and Modulator stages of the transmitter. Use the ground jack located on the power supply chassis.

7. With the meter lead moved to the MULT-2 jack, J102 (green-negative), key the transmitter and tune Z102 ("1") and Z105 ("2") for maximum meter reading (greater than 1.0 volt).

CAUTION

Do not key the transmitter for longer than 30 seconds in each minute until the 3rd Multiplier grid has been tuned.

8. Alternately tune Z108 ("3") and Z111 ("4") for maximum meter reading (greater than 1.0 volt) at the MULT-3 jack, J103 (green-negative).

It is sometimes possible to tune the first or second group of multipliers to the wrong harmonic of the crystal frequency. The coils will ordinarily be correctly tuned if the slugs are first screwed all the way in (when the transmitter is operating below the middle of its frequency range), or all the way out, (when the transmitter is operating above the middle of its frequency range), and the slugs are then tuned for the first peak encountered.

9. Alternately peak Z114 ("5") and Z117 ("6") while metering at the PA GRID jack, J105 (green-negative). Fixed bias on the PA grid will appear as a small initial reading (0.5 - 1.0 volt) at J105, whether or not Z114 and Z117 are correctly tuned. The meter should read greater than 1.5 volts for proper tuning.

A slight dip at the MULT-3 jack may be used as an indication of resonance of Z114 if both Z114 and Z117 are badly misaligned.

10. Connect the meter at the CATH PA jack, J106 (red-positive), key the transmitter and tune the PA PLATE control (C136) for minimum meter reading.

11. Switch the TUNE-OPERATE switch to OPERATE and re-tune the PA PLATE for minimum meter reading. The neon lamp should be at minimum brightness.

12. Rotate the ANT COUPLING control slightly clockwise.

13. Tune the ANT TUNING control for maximum brightness of the neon lamp (I101).

14. Rotate the ANT COUPLING control clockwise until the CATH PA meter reads 1.5 volts. In coupling, the neon lamp should not go through a maximum.

15. Repeat steps 13 and 14 and lock the ANT COUPLING control.

PA ALIGNMENT USING RF INDICATOR LAMP

The neon glow RF Indicator, I101 is located on the chassis near the PA housing. In an emergency, the power amplifier may be aligned using I101 as a tuning indicator. The transmitter must already be aligned through the PA grid.

1. Set the TUNE-OPERATE switch on OPERATE and turn the ANT COUPLING control fully counterclockwise.

2. Key the transmitter and adjust the PA PLATE control for minimum brightness of I101.

3. Tune Z114 ("5") and Z117 ("6") for minimum brightness of the neon lamp.

4. Rotate the ANT COUPLING control slightly clockwise and adjust the ANT TUNING control for maximum brightness of the neon lamp.

5. Rotate the ANT COUPLING control clockwise for maximum brightness of the neon lamp.

6. Check that the ANT TUNING control is adjusted for maximum brightness.

The transmitter is now aligned and delivering maximum power to the antenna. However, since I101 gives no indication of the actual value of plate current being drawn, is is advisable to continue with the next step, to lessen the possibility of exceeding the PA tube ratings.

7. Back the ANT COUPLING off counterclockwise until a slight decrease in the brilliance of the neon lamp is noted and lock the control at that position.

TRANSMITTER BENCH ALIGNMENT PROCEDURE

FREQUENCY ADJUSTMENT

The Oscillator crystal is ground to within .002 percent of the recorded frequency. The FREQ. Adjust trimmer, C101, should be used to set the transmitter on frequency while using an accurately calibrated Frequency Meter which meets the requirements of the FCC.

MODULATION LEVEL ADJUSTMENT

The modulation level control, R186, was adjusted to the proper setting before shipment and should not normally require readjustment. This setting permits approximately 60 percent modulation for the average voice level. The occasional audio peaks which would cause overmodulation are limited by the modulation limiter (V109). The limiter instantaneously limits the slope of the audio wave, preventing overmodulation, but preserving the intelligibility of the transmission.

Test Equipment

1. An audio oscillator.
2. A frequency modulation monitor.
3. An output meter or a vacuum tube voltmeter.

Procedure

1. Connect the audio oscillator and the meter across pins 1 and 2 of the microphone receptacle on the power supply chassis. Pin 1 is the audio low.

2. Apply a 1.0 volt signal at 1000 cps across the microphone terminals.

3. Disconnect the microphone from the control unit and key the transmitter by means of the test switch on the Power Supply chassis.

4. Set the MOD control (R186) for a 13 to 15-kilocycle swing* as indicated on the frequency modulation monitor.

If no audio oscillator is available, the modulation level control can be set by connecting a microphone to the transmitter, whistling a loud, clear tone into the microphone and setting the MOD control (R186) for a 13 to 15-kilocycle swing* as indicated on the modulation monitor.

---

*Because of the high selectivity of General Electric Mobile Radio equipment, excessively high swings can impair communication effectiveness as well as excessively low swings. Within the range of settings recommended, good performance should be obtained. In general, more problems arise from high swing settings than from low. For this reason, the modulation control is set for a ± 13-kilocycle swing when the equipment is shipped from the factory.

PARTS LIST
TRANSMITTER MODEL 4ET22A2

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
C101		Capacitor, variable, air dielectric; 1.98 to 7.83 mmfd, 1250 v peak.	Chan. A freq trim.
C102		Capacitor, fixed, ceramic dielectric; temp compensating, tubular, 6.0 mmfd ± 0.5 mmfd, 500 v d-c w.	Oscillator grid.
C103		Capacitor, fixed, ceramic dielectric; temp compensating, tubular, 47 mmfd ± 10%, 500 v d-c w.	Oscillator cathode.
C104		Capacitor, fixed, ceramic dielectric; Hi-K disk, 0.0015 mfd +100% -0%, 500 v d-c w.	Oscillator screen.
C108		Same as C103.	Mod. grid coupling.
C110		Capacitor, fixed, ceramic dielectric; temp compensating, tubular, 22 mmfd ± 10%, 500 v d-c w, -80 temp coef.	Mod. plate coupling.
C112		Same as C104.	Mod. cathode by-pass.
C113		Capacitor, fixed, electrolytic; polarized twist prong base. Two sections, Section B 10 mfd +50% -10%, 400 v d-c w, Section A 20 mfd +250% -10%, 50 v d-c w.	Section A-mod. cathode by-pass, Section B-audio supply by-pass.
C116		Same as C104.	1st doubler screen by-pass.
C117		Same as C103.	1st doubler grid coupling.
C120		Same as C104.	Tripler screen by-pass.
C121		Same as C102.	Oscillator plate.
C123		Same as C104.	2nd doubler screen by-pass.
C125		Capacitor, fixed, ceramic dielectric; temp compensating, tubular, 10 mmfd ± 0.5 mmfd, 500 v d-c w, -80 temp coef.	PA grid.
C129		Same as C104.	Cathode by-pass.
C130		Same as C104.	Cathode by-pass.
C131		Same as C104.	Cathode by-pass.
C132		Same as C104.	PA screen by-pass.
C134		Capacitor, fixed, mica dielectric; 470 mmfd ± 10%, 1500 v d-c w.	PA plate coupling.
C135		Same as C134.	PA plate by-pass.
C136		Capacitor, variable, air dielectric; 6.5 to 50 mmfd, 1200 v, 60 cycle test.	PA plate tuning.
C137		Capacitor, fixed, mica dielectric; CM15 case, Class C, 100 mmfd ± 5%, 500 v d-c w.	PA grid return.
C138		Capacitor, fixed, mica dielectric; 10 mmfd ± 10%, 500 v d-c w, class B.	PA plate
C139		Same as C136.	Ant. tuning.
C142		Capacitor, fixed, ceramic dielectric; temp compensating, tubular, 2.0 mmfd ± 0.5 mfd, 500 v d-c w.	Indicator coupling.
C143		Capacitor, fixed, ceramic dielectric; feed through, 100 mmfd ± 20%, 750 v d-c w.	Ant. coupling by-pass.
C144		Capacitor, fixed, ceramic dielectric; Hi-K disk, 0.02 mfd +100% -0%, 500 v d-c w.	2nd audio amp. cathode by-pass.
C145		Capacitor, fixed, ceramic dielectric; stabilized Hi-K disk, 1000 mmfd ± 10%, 500 v d-c w.	2nd limiter.
C147		Same as C104.	Bias by-pass.
C148		Capacitor, fixed, ceramic dielectric; Hi-K disk, 0.005 mfd +100% -0%, 500 v d-c w.	1st audio amp.grid coupling.
C149		Same as C104.	Ant. jack coupling.
C154		Capacitor, fixed, mica dielectric; CM15 case, Class C, 82 mmfd ± 5%, 500 v d-c w.	Ant. Filter series.

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
C155		Capacitor, fixed, mica dielectric; class C, 100 mmfd ± 5%, 500 v d-c w.	Ant. filter shunt.
C156		Same as C155.	Ant. filter shunt.
C157		Same as C154.	Ant. filter series.
C173		Capacitor, fixed, ceramic dielectric; Hi-K, 100 mmfd ± 20%, 500 v d-c w.	1st audio amp grid by-pass.
C174		Capacitor, fixed, mica dielectric; class C, 330 mmfd ± 10%, 500 v d-c w.	2nd audio grid coupling.
C178		Capacitor, fixed, paper dielectric; molded plastic, 0.01 mfd ± 20%, 400 v d-c w.	1st limiter grid coupling.
C179		Same as C173.	2nd limiter grid by-pass.
C182		Capacitor, fixed, paper dielectric; molded plastic, 0.022 mfd ± 20%, 400 v d-c w.	2nd limiter grid coupling.
C183		Capacitor, fixed, paper dielectric; molded plastic, 0.1 mfd ± 20%, 400 v d-c w.	2nd limiter plate coupling.
C184		Capacitor, fixed, ceramic dielectric; stabilized Hi-K disk, 2700 mmfd ± 10%, 500 v d-c w.	Mod. deemphasis
I101		Lamp, glow; 105-125 v circuit, 1/25 w, unbased wire terminal.	Neon power indicator.
J101		Jack, tip; test point jack, phenolic or Urea.	Multi 1.
J102		Same as J101.	Multi 2.
J103		Same as J101.	Multi 3.
J105		Same as J101.	PA grid.
J106		Jack, tip; test point jack, phenolic or Urea.	PA cathode.
J111		Jack, tip; phono type, mica filled phenolic.	Antenna.
J112		Same as J111.	Rec.
K101		Relay; 5 to 7.5 v d-c nominal coil, pick up less than 4.5 v d-c at 25°C, drop out 2.25 v d-c or less at 85°C, resistance 20 ohms ± 8% at 25°C, 1 form C, 1 form B contacts, contact pressure 30 gram min.	Antenna transfer.
L101		Choke, radio frequency; inductance 765.0 uh ± 10%, current 33 ma, resistance 17.5 ohms. Type R-33.	Oscillator plate.
L102		Same as L101.	Mod. plate.
L105		Coil, radio frequency; 3-1/2 turns close wound left hand, 0.875" ID. B22F1 #14 Awg. 0.064" dia.	PA plate
L108		Choke, radio frequency; inductance 7.0 uh, current 1000 ma, frequency range 35-110 mc, red.	PA plate feed.
L111		Coil, radio frequency; 5-1/2 turns close wound right hand, 0.875" ID. B22F1 #14 Awg. 0.064" dia.	Ant. Coupling
L113		Coil, radio frequency; 2-1/2 turns, 0.250" ID. B22F1 #20 Awg.	Ant. filter.
L115		Same as L113.	Ant. filter.
L116		Coil, radio frequency; 5-1/2 turns at 13 turns per inch, 0.465" ID. B22F1 #14 Awg.	Ant. filter.
P101		Connection, plug, electrical; part of W101.	Power and control.
R101		Resistor, fixed, composition; 0.10 megohms ± 10%, 1/2 w.	Oscillator grid.
R102		Resistor, fixed, composition; 2200 ohms ± 10%, 1/2 w.	Oscillator cathode bias.
R103		Resistor, fixed, composition; 82,000 ohms ± 10%, 1/2 w.	Oscillator screen drop.
R107		Same as R101.	Mod. grid.
R109		Resistor, fixed, composition; 3300 ohms ± 10%, 1/2 w.	Mod. cathode bias.
R114		Same as R103.	1st doubler screen drop.

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R115		Same as R101.	1st doubler grid.
R116		Resistor, fixed, composition; 22,000 ohms ± 10%, 1/2 w.	Mult 1 metering.
R121		Resistor, fixed, composition; 3900 ohms ± 10%, 1/2 w.	Tripler metering.
R123		Same as R101	Tripler screen drop.
R128		Resistor, fixed, composition; 6800 ohms ± 10%, 1/2 w.	Mult 2 metering.
R130		Resistor, fixed, composition; 39000 ohms ± 10% 1 w.	2nd doubler screen drop.
R139		Resistor, fixed, composition; 10,000 ohms ± 10%, 1/2 w.	PA grid metering.
R143		Resistor, fixed, wirewound; precision, 10 ohms ± 1%, 2 w.	PA cathode metering.
R144		Resistor, fixed, composition; 6800 ohms ± 10%, 3 w.	PA screen drop.
R147		Resistor, fixed, composition 27,000 ohms ± 10%, 1 w.	PA grid bias.
R150		Resistor, fixed, composition; 0.18 megohms ± 10%, 1 w.	Tune Oper.
R154		Resistor, fixed, composition; 10.0 megohms ± 10%, 1/2 w.	Indicator series.
R157		Resistor, fixed, composition; 39 ohms ± 10%,2w.	Filament balancing.
R165		Resistor, fixed, composition; 1.0 megohms ± 10%, 1/2 w.	1st audio amp. grid.
R166		Resistor, fixed, composition; 470 ohms ± 10%, 1/2 w.	1st audio amp. cathode.
R167		Same as R101.	1st audio amp.plate.
R168		Same as R139.	Audio dropping.
R171		Same as R102.	2nd audio amp. cathode.
R172		Same as R101.	2nd audio amp.plate.
R174		Same as R101.	2nd audio amp. grid.
R175		Same as R103.	2nd limiter output.
R176		Same as R101.	2nd limiter feed back.
R178		Resistor, fixed, composition; 0.47 megohms ± 10%,1/2 w.	1st limiter grid.
R179		Same as R101.	1st limiter grid.
R180		Resistor, fixed, composition; 0.22 megohms ± 10%, 1/2 w.	1st limiter plate.
R181		Same as R121.	1st limiter cathode.
R182		Resistor, fixed, composition; 47,000 ohms ± 10%, 1/2 w.	2nd limiter grid coupling.
R183		Same as R121.	2nd limiter cathode.
R184		Same as R182.	2nd limiter grid.
R186		Resistor, variable; carbon film, 100,000 ohms ± 20%, linear taper, 0.2 w, with split bushing and locking nut.	Mod. level.
R187		Same as R180.	Mod. deemphasis.
R189		Same as R165.	Ant. by-pass.
S101		Switch, toggle; spst, 3 amp at 250 v.	Tune oper.
V101		Tube, type 6BH6.	Oscillator.
V102		Tube, type 6U8.	Modulator and 1st doubler.
V103		Same as V101.	Tripler.
V104		Electron tube; type 6CL6.	2nd doubler.
V105		Electron tube; type 6146.	PA
V109		Electron tube; type 12AU7.	1st and 2nd audio amp.
V110		Same as V109.	1st and 2nd limiter.

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
W101		Cable, special purpose, electrical; includes molded connector with 11 male contacts, connector color red.	Power and control.
XV101		Socket, electron tube; includes shield, mica filled phenolic, 7 pin miniature, bottom mount, flat top with 4 ground ears.	Oscillator.
XV102		Socket, electron tube; includes shield, mica filled phenolic, 9 pin miniature, 4 ground ears.	Modulator and 1st doubler.
XV103		Same as XV101.	Tripler.
XV104		Same as XV102.	2nd doubler.
XV105		Socket, electron tube; 8 pin.	PA.
XV109		Same as XV102.	1st and 2nd audio amp.
XV110		Same as XV102.	1st and 2nd limiters.
XY101		Socket, electron tube; crystal socket with ring octal, mica filled phenolic.	Crystal.
Y101		Crystal Unit, quartz; unheated, ground to specific frequency within range, freq 2.0 to 4.5 mc, temp range o to 90°C, -30 to +90°C. When reordering give G-E Dwg. and Parts No. and specify exact frequency of each crystal.	Crystal.
Z102		Assembly; includes replacable component Z102-C1,C3,C4 and R1.	V102, 1st doubler tuned plate load.
Z102-C1		Capacitor, fixed, ceramic dielectric; disk, insulated, temp compensating, 39 mmfd ± 10%, 500 v d-c w.	
Z102-C3 and Z102-C4		Capacitor, fixed, ceramic dielectric; stabilized Hi-K disks, 2000 mmfd ± 10%, 500 v d-c w.	
Z102-R1		Resistor, fixed, composition; 5600 ohms ± 10%, 1/2 w.	
Z105		Assembly; includes replacable components Z105-C2,C4 and R1.	V103, tripler tuned grid circuit.
Z105-C2		Capacitor, fixed, ceramic dielectric ; disk, insulated, temp compensating, 39 mmfd ± 10%, 500 v d-c w.	
Z105-C4		Capacitor, fixed, ceramic dielectric; stabilized, Hi-K disk, 1500 mmfd ± 10%, 500 v d-c w.	
Z105-R1		Resistor, fixed, composition; 0.10 megohm ± 10%, 1/2 w.	
Z108		Assembly; includes replaceable components Z108-C2,C5 and R1.	V103, tripler tuned plate load.
Z108-C2		Capacitor, fixed, ceramic dielectric; disk, insulated temp compensating, 27 mmfd ± 10%, 500 v d-c w.	
Z108-C5		Capacitor, fixed, ceramic dielectric; stabilized, Hi-K disk, 2000 mmfd ± 10%, 500 v d-c w.	
Z108-R1		Resistor, fixed, composition; 8200 ohms ± 10%, 1/2 w.	
Z111		Assembly; includes replaceable components Z111-C2,C4 and R1.	V104, 2nd doubler tuned grid circuit.
Z111-C2		Capacitor, fixed, ceramic dielectric; disk, insulated, temp compensating, 27 mmfd ± 10%, 500 v d-c w.	
Z111-C4		Capacitor, fixed, ceramic dielectric; stabilized, Hi-K disk, 1500 mmfd ± 10%, 500 v d-c w.	
Z111-R1		Resistor, fixed composition; 0.10 megohm ± 10%, 1/2 w.	

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
Z114		Assembly; includes replaceable components Z114-C1,C2,C3 and R1.	V104, 2nd doubler tuned plate load.
Z114-C1		Capacitor, fixed, ceramic dielectric; Hi-K disk, 0.0015 mfd +100% -0%, 500 v d-c w.	
Z114-C2		Capacitor, fixed, ceramic dielectric; temp compensating, tubular, 1.0 mmfd ± 0.5 mmfd, 500 v d-c w, -80 temp coef.	
Z114-C3		Capacitor, fixed, ceramic dielectric; temp compensating, tubular, 2.0 mmfd ± 0.5 mmfd, 500 v d-c w, -80 temp coef.	
Z114-R1		Resistor, fixed, composition; 2200 ohms ± 10%, 1 w.	
Z117		Assembly; includes replaceable component R1.	V105, PA grid tuned grid circuit.
Z117-R1		Resistor, fixed, composition; 0.33 megohm ± 10%, 1/2 w.	
Z123		Assembly.	PA plate suppressor.

STOCK NUMBER IDENTIFICATION
TRANSMITTER MODEL 4ET22A2

Ref. Symbol	General Electric Part Number	Manufacturer's Part Number		Stock Number
C 101	M-7481115-P2	JON	Cat. #160-104-43	N16-C058094-5911
C 102	P-7770468-P6	ERC	Style 331 **	N16-C015619-1211
C 103	P-7770468-P17	ERC	Style 331 **	N16-C016538-4031
C 104	C-7774750-P5	AB	Cat. #24-152X	For Replacement use SNSN N16-C018792-7646
C 110	P-7770468-P213	ERC	Style 331 **	N16-C016153-4356
C 113	P-7770994-P19	MAL	Type FP **	N16-C021583-5943
C 125	P-7770468-P210	ERC	Style 331 **	N16-C015930-1002
C 134	B-7478981-P2	MIC	Type RCM20B47K	N16-C030115-6759
C 136	M-7476674-P9	TEE	Special *	N16-C059851-9914
C 137	P-3R122-P47	EMM	Type CM-15 **	N16-C028553-1041
C 138	P-3R141-P2	MIC	Type RCM20B100K	For Replacement use SNSN N16-C026025-8276
C 142	P-7770468-P2	ERC	Style 331 **	N16-C015435-8098
C 143	B-7485975-P16	ERC	Style 327 **	N16-C017091-8430
C 144	C-7774750-P15	AB	Cat. #40-203X	N16-C019143-3758
C 145	C-3R81-P102K	RAMT	Type JL **	N16-C018653-9248
C 148	C-7774750-P11	AB	Cat. #36-502X	For Replacement use SNSN N16-C018982-9980
C 154	P-3R122-P45	EMM	Type CM-15 **	N16-C028210-1394
C 155	P-3R141-P127	MIC	Type RCM20C101J	N16-C028553-1201
C 173	M-7483722-P1	ERC	Style 331-Hi-K**	N16-C017091-7660
C 174	P-3R141-P50	MIC	Type RCM20C331K	For Replacement use SNSN N16-C029713-6806
C 178	B-7488996-P1	SMO	Type 33 **	For Replacement use SNSN N16-C042765-5354
C 182	B-7488996-P2	SMO	Type 33 **	For Replacement use SNSN N16-C040120-4736
C 183	B-7488996-P3	SMO	Type 33 **	For Replacement use SNSN N16-C045773-8706
C 184	C-3R81-P272K	RAMT	Type JL **	N16-C018917-7926
I 101	NE-2	G-E	Cat. #NE-2	GT-6240-179-1811
J 101	A-7143966-P4	APDP	Type 110BCS-green	N17-J039985-3554
J 106	A-7143966-P2	APDP	Type 110BCS-red	N17-C073108-1901
J 111	K-7104941-P4	CIN	Cat. #14K-12699	N17-C073114-1484
K 101	B-7486116-P7	APSC	Cat. #FX-63A	N17-R065145-1876
L 101	K-7127925-P5	NAC	Type R33 **	N16-C074145-2916
L 105	A-7145956-P2	GE		Shop Manufacture
L 108	P-7772834-P4	OM	Cat. #Z-50	N16-C073045-9468
L 111	A-7145958-P1	GE		Shop Manufacture
L 113	A-7146644-P1	GE		Shop Manufacture
L 116	A-7146645-P2	GE		Shop Manufacture
*R 101	C-3R77-P104K	IRC	Type BTS **	N16-R050633-0785
R 102	C-3R77-P222K	IRC	Type BTS **	N16-R050012-0816
R 103	C-3R77-P823K	IRC	Type BTS **	N16-R050588-0818
R 109	C-3R77-P332K	IRC	Type BTS **	N16-R050066-0816
R 116	C-3R77-P223K	IRC	Type BTS **	N16-R050372-0833
*P 101				For Reference only

STOCK NUMBER IDENTIFICATION
TRANSMITTER MODEL 4ET22A2

Ref. Symbol	General Electric Part Number	Manufacturer's Part Number		Stock Number
R 121	C-3R77-P392K	IRC Type BTS	**	N16-RO50093-0816
R 128	C-3R77-P682K	IRC Type BTS	**	N16-RO50201-0818
R 130	C-3R78-P393K	AB Type GB	**	N16-RO50445-0233
R 139	C-3R77-P103K	IRC Type BTS	**	N16-RO50282-0725
R 143	K-7119855-P3	SLC Type 220RA	**	For Replacement use SNSN N16-RO79837-2520
R 144	C-3R148-P682K	AB Type GM	**	N16-RO50202-0571
R 147	C-3R78-P273K	AB Type GB	**	N16-RO50400-0240
R 150	C-3R78-P184K	AB Type GB	**	N16-RO50697-0238
R 154	C-3R77-P106K	IRC Type BTS	**	N16-RO51326-0818
R 157	C-3R79-P390K	AB Type HB	**	For Replacement use SNSN N16-RO49391-0121
R 165	C-3R77-P105K	IRC Type BTS	**	N16-RO50975-0725
R 166	C-3R77-P471K	IRC Type BTS	**	N16-RO49769-0799
R 178	C-3R77-P474K	IRC Type BTS	**	N16-RO50822-0761
R 180	C-3R77-P224K	IRC Type BTS	**	N16-RO50714-0818
R 182	C-3R77-P473K	IRC Type BTS	**	N16-RO50479-0440
R 186	B-7487391-P101	CPH Type 70	**	N16-RO88010-6928
S 101	A-7145985-P1	AHH Cat. #20994-WD		N17-SO70918-5931
V 101		G-E Type 6BH6		N16-TO56213-0020
V 102		G-E Type 6U8		N16-TO56729-0000
V 104		G-E Type 6CL6		N16-TO56240-0000
V 105		EMC Type 6146		N16-TO76146-0000
V 109		G-E Type 12AU7		N16-TO58241-0000
W 101	A-7144612-P1	CMS Cat. #1601-M11		N17-CO48439-1438
XV 101	P-7768887-P14	EBY Cat. #9180		N16-SO62598-5407
XV 102	M-7480532-P8	EBY Cat. #9713-20		N16-SO64062-6407
XV 105	K-7132886-P1	CIN Cat. #2121		For Replacement use SNSN N16-SO63514-1901
XY 101	A-7140823-P2	CIN Cat. #9865		N16-SO63462-8281
Y 101	A-7147191-P1	GE		Gov't. Furnished Mat'l.
Z 102	PL-7486448-G1	GE		N16-CO72633-3477
Z 102-C1	C-7774846-P16	ERC Style 811	**	For Reference only
Z 102-C3	C-3R81-P202K	RAMT Type JL	**	For Reference only
Z 102-R1	C-3R77-P562K	IRC Type BTS	**	For Reference only
Z 105	PL-7486470-G2	GE		N16-CO72633-3488
Z 105-C2	C-7774846-P16	ERC Style 811	**	For Reference only
Z 105-C4	C-3R81-P152K	RAMT Type JL	**	For Reference only
Z 105-R1	C-3R77-P104K	IRC Type BTS	**	For Reference only
Z 108	PL-7486471-G2	GE		N16-CO72633-1024
Z 108-C2	C-7774846-P13	ERC Style 811	**	For Reference only
Z 108-C5	C-3R81-P202K	RAMT Type JL	**	For Reference only
Z 108-R1	C-3R77-P822K	IRC Type BTS	**	For Reference only
Z 111	PL-7486481-G2	GE		N16-CO72189-3259
Z 111-C2	C-7774846-P14	ERC Type 811	**	For Reference only
Z 111-C4	C-3R81-P152K	RAMT Type JL	**	For Reference only
Z 111-R1	C-3R77-P104K	IRC Type BTS	**	For Reference only

STOCK NUMBER IDENTIFICATION
TRANSMITTER MODEL 4ET22A2

Ref. Symbol	General Electric Part Number	Manufacturer's Part Number			Stock Number
Z 114	PL-7486456-G2	GE			N16-C072210-3446
Z 114-C1	C-7774750-P5	AB	Cat. #24-152X		For Reference only
Z 114-C2	P-7770468-P201	ERC	Style 331	**	For Reference only
Z 114-C3	P-7770468-P202	ERC	Style 331	**	For Reference only
Z 114-R1	C-3R78-P222K	AB	Type GB	**	For Reference only
Z 117	PL-7486458-G1	GE			N16-C076285-5059
Z 117-R1	C-3R77-P334K	IRC	Type BTS	**	For Reference only
Z 123	PL-7145305-G1	GE			N16-S089854-1114

* This part has been manufactured to meet General Electric Purchase Specifications. When ordering from the manufacturer, order by General Electric Part Number.

** When ordering this part from the manufacturer, specify type and information included under name and description.

* Transmitter Model 4ET22A2 employs one 6146 Power Amplifier Tube.

Transmitter Model 4ET23A2 employs two 6146 Power Amplifier Tubes.

Block Diagram

30-42 MC TRANSMITTER
MODELS 4ET22A2 and 4ET23A2

(RC-357 Mod.)

TYPICAL VOLTAGE READINGS FROM TUBE SOCKET PINS TO GND.

	9	8	7	6	5	4	3	2	1	TUBE TYPE	SYMBOL
			150	150	2.0	(2)	(2)	7.2	6.3	6BH6	V101
										6BH6	V102
			0	300	(1)	(2)	166	8.8	200	6BH6	V103
			1.6	185	3.0	(2)	175	135	50	6CL6	V104
			175	175	3.0	(2)	255	0	0	6146	V105
			-70.0	-70.0	1.6	-40.0	255	1.6	1.6	6146	V106
			8.6	0	1.6	(2)	3.6	0	175	12AU7	V107
			0	0	50	(2)	4.6	0	100	12AU7	V108

(3)

	9	8	7	6	5	4	3	2	1	TUBE TYPE	SYMBOL
										6BH6	V109
			0	0	0	0	0	0	0	6CL6	V110
			0	0	0	0	0	0	0	6CL6	V111
			0	0	0	0	0	0	0	6CL6	V112
			0	0	0	0	0	0	0	6CL6	V113
			0	0	0	0	0	0	0	6CL6	V114

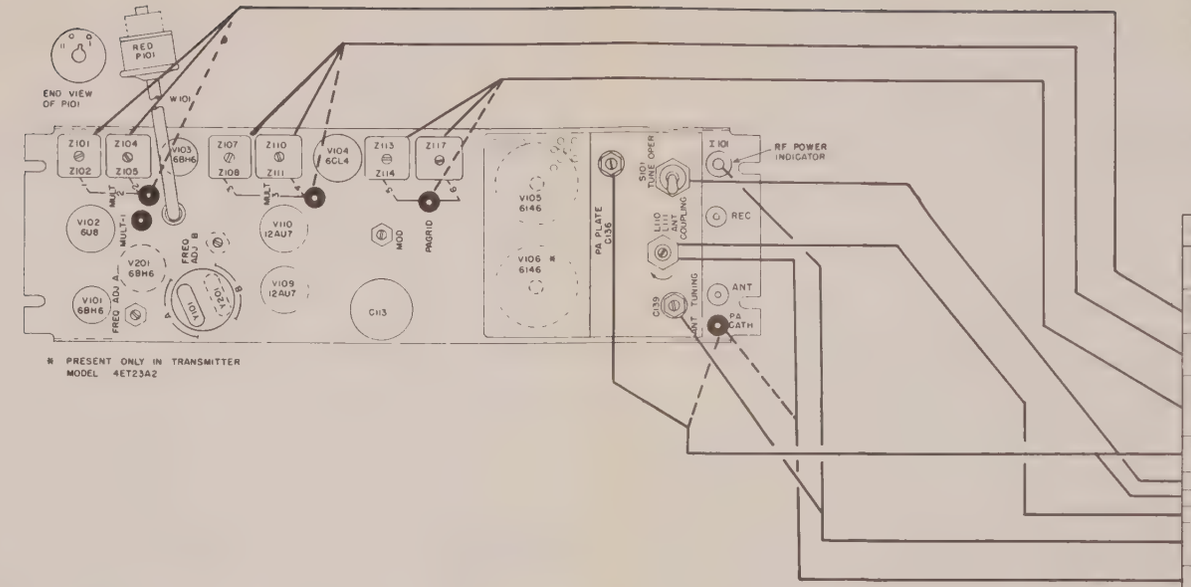
READ AND ARE TYPICAL VOLTAGES MEASURED ON A 20,000 OHM-PER-VOLT VOLTMETER (SCALES OF 3, 12, 60, 300, 600 VOLTS) WITH THE TRANSMITTER LOADED TO RATED CATHODE CURRENT.

① TAKEN WITH VACUUM TUBE VOLTMETER OTHERWISE MEASUREMENT WOULD BE ZERO VOLTS.
FILAMENT TO 6.3 OR 12 V DEPENDING ON CONNECTIONS.
CHANNEL SELECTOR SWITCH ON CHAN A (2 FREQ. TRANSMITTER).
② NO MODULATION.

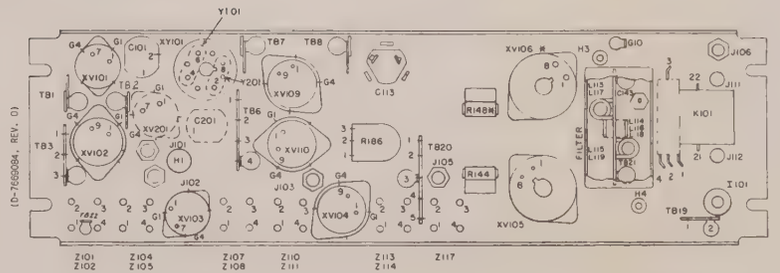
READINGS ARE TYPICAL RESISTANCES MEASURED WITH ALL POWER REMOVED FROM TRANSMITTER AND WITH CABLES DISCONNECTED AND TUBES IN PLACE.

① FILAMENT CIRCUIT. VERY LOW RESISTANCE.
② WILL READ INFINITY ON 2-FREQUENCY UNIT.
③ MODULATION CONTROL TURNED FULLY CLOCKWISE.

TYPICAL TERM NUMBERING FOR TB1 - TB2 - TB3 & TB7.



* PRESENT ONLY IN TRANSMITTER MODEL 4ET23A2



SIMPLIFIED BENCH ALIGNMENT PROCEDURE

These instructions are intended for retuning Transmitter Types ET-22-A and ET-23-A. If the transmitter is badly misaligned or if the frequency of the transmitter is to be changed, refer to the complete TRANSMITTER BENCH ALIGNMENT PROCEDURE (see Table of Contents).

PRELIMINARY OPERATION:

1. Be sure CRYSTAL is connected between pins 4 and 6 of crystal socket XY101 (Channel B crystal between pins 2 and 8 for two-frequency operation) and ANTENNA or other suitable 50-ohm load is connected to transmitter.
2. Place TUNE-OPERATE switch to TUNE position.
3. Rotate ANT COUPLING control to extreme COUNTERCLOCKWISE position.
4. Turn POWER ON and allow 30 seconds for WARMUP.
5. On two-frequency transmitters, turn Channel-Selector Switch to CHANNEL A.
6. Check oscillator frequency. If necessary, set transmitter on frequency by means of crystal trimmer FREQ ADJ A (C101).

NOTE: Do not key the transmitter for more than 30 seconds in each minute until the 3rd Multiplier Grid has been tuned.

The transmitter can be completely aligned using the 0 to 3-volt scale of a 20,000 ohm-per-volt voltmeter. The meter readings given are those which should be obtained using such a meter.

METERING JACK −	METERING JACK +	TUNING CONTROL	METER READING	PROCEDURE
MULT-1 J103 green	GND			A meter reading of at least 1.0 volt indicates proper operation of Oscillator and Modulator stages. (In 2-frequency transmitters, drive from both oscillators should be equal.)
[illegible]		Z101 (or Z102) (Mult-1 Plate) and Z103 (or Z105) (Mult-2 Grid) (2)	Maximum (1.0 volt*)	
MULT-2 J103 green		Z107 (or Z108) (Mult-2 Plate) Z110 (or Z111) (Mult-3 Grid) (4)	Maximum (1.0 volt*)	Alternately peak Z107 (or Z108) and Z110 (or Z111). If both coils are badly misaligned, refer to TRANSMITTER BENCH ALIGNMENT PROCEDURE. Check tuning with wavemeter.
PA GRID J105 green		Z113 (or Z114) (Mult-3 Plate) Z117 (PA Grid) (6)	Maximum (1.5 volts*)	Alternately peak Z113(or Z114) and Z117. Fixed bias on PA grid will appear as small initial reading whether or not coils are correctly tuned. Slight dip at MULT-3 jack may be used as indication of resonance of Z113 (or Z114) if both Z113 (or Z114) and Z117 are badly misaligned.
GND	CATH PA J106 red	PA PLATE (C136)	[illegible]	
				Switch TUNE-OPERATE switch to OPERATE.
				The neon lamp (I101) should be at minimum brightness.
				Rotate ANT COUPLING control slightly clockwise.
		ANT TUNING (C139)	Maximum brightness of neon lamp	Tune the ANT TUNING control for maximum brightness of the neon lamp (I101).
		ANT COUPLING (L114)	[illegible] volts	Rotate ANT COUPLING control clockwise until CATH PA meter reads 1.5 volts. In coupling, neon lamp should not go through maximum.
				Repeat two preceding steps and lock ANT COUPLING control.

* Minimum meter reading to be expected when tuning with a 0 to 3-volt, 20,000 ohm-per-volt voltmeter. If possible, tune to exceed given reading.

———— SOLID LINES INDICATE TUNING CONTROLS.

- - - - - - - - BROKEN LINES INDICATE METERING JACKS.

Service Outline

30-42 MC TRANSMITTER
MODELS 4ET22A2 and 4ET23A2

(RC-354A Mod.) 2-25

HINTS FOR SERVICING

The following list of service hints, in addition to the table of minimum metering voltages which follows and the voltage-resistance chart on the reverse side will assist the serviceman in isolating the source of trouble if the transmitter should fail to operate properly. Resistance readings should be read with P101 disconnected from the power supply.

1. Do all filaments light?

   Yes - See step 2.

   No - Is there about 6 volts at XV102-4 and, in 12-volt systems, about 12 volts at XV103-3?

   Yes - Follow orange and brown wires in transmitter.

   No - Refer to SERVICE OUTLINE for Transmitter Power Supply.

2. Does transmitter key?

   Yes - See step 3.

   No - With transmitter keyed, is there 6 volts on green wire at K101?

   Yes - Check for missing ground or defective relay.

   No - Refer to SERVICE OUTLINE for Transmitter Power Supply.

3. Is grid voltage at MULT-1 jack above minimum (see table which follows)?

   Yes - See step 4.

   No - (1) Check V101 and V102.
   (2) Check the Channel A crystal.
   (3) Is 200 volts d-c present at power supply jack with transmitter keyed?

   Yes - Trace voltage to TB2-2, XV101-5 and lower voltage at screen and cathode of XV101-2 (see voltage-resistance chart).

   No - Refer to SERVICE OUTLINE for Transmitter Power Supply.

   (4) Is oscillator cathode resistor grounded?

   Yes - Continue to (5).

   No - In single-frequency transmitters, make ground. In two-frequency transmitters, trace ground through power supply and control unit to Channel-Selector Switch.

   (5) Check resistance readings on XV101 and XV102 (see voltage-resistance chart).
   (6) Check for resistance reading of 22K ohms from MULT-1 jack to ground.
   (7) Check C102, C103, C104, C109 and C117.

4. Are grid voltages at MULT-2, MULT-3 and PA GRID jacks above minimum (see table which follows)?

   Yes - See step 5.

   No - (1) Check MULT-1, MULT-2, MULT-3 and PA GRID jacks in that order.
   (2) Check tuning of stage preceding jack in question.
   (3) Check tube in stages preceding and following jack.
   (4) Is + 330 volts d-c present at TB22 and at TB6-2?

   Yes - Trace voltage to plate, screen and cathode of preceding multiplier stage (see voltage-resistance chart).

   No - Refer to SERVICE OUTLINE for Transmitter Power Supply.

   (5) Check resistance readings on pins of tube socket in preceding stage (see voltage-resistance chart).
   (6) Check for high resistance from grid of tube following jack with low reading to ground.
   (7) Check for correct resistance from metering jack to ground.
   (8) Check for energy at correct frequency at multiplier plate, using wavemeter.
   (9) Inspect and check components in second multiplier can.
   (10) Inspect and check screen bypass condenser.

5. Is there a good reading at MULT-3 jack, but no PA GRID voltage?

   No - See step 6.

   Yes - Check tuning of Z107 (or Z108) and Z110 (or Z111) with wavemeter.

6. Does TUNE-OPERATE switch operate properly?

   Yes - See step 7.

   No - (1) See if switch is defective.
   (2) See if R150 (or R151) is open or shorted.

7. Will PA PLATE tuning dip properly on OPERATE?

   Yes - See step 8.

   No - Does CATH PA always read below 0.5 volt or above 1.5 volts?

   Below 0.5 volt -

   (1) Check "HV-B+" voltage on power supply chassis.
   (2) Check PA screen voltage. (Neon lamp will glow if adequate screen voltage is present.)
   (3) Check for short in PA B+.

   Above 1.5 volts -

   (1) Recheck drive at PA GRID jack.
   (2) Check coils and capacitors in PA plate tank.
   (3) Check resonant frequency of PA plate tank with wavemeter.

8. Is transmitter delivering proper power to wattmeter?

   Yes - See step 9.

   No - Does neon lamp light with transmitter keyed?*

   Yes - (1) Check antenna connector.
   (2) Check antenna tuning.
   (3) Inspect components and linkage in PA.

   No - (1) Inspect components in low-pass filter.
   (2) Does neon lamp light when filter is bypassed by a jumper from feed-through capacitor C143 to the antenna jack?

   Yes - Check for defect in filter or relay.

   No - Check C143.

   (3) Carefully inspect L110 (or L111), C139, C146 and ANT COUPLING.

* A very bright glow in the neon lamp indicates that RF power from the transmitter is not reaching the antenna. A dim glow or no glow indicates that RF power is not available beyond the filter.

9. Is transmitter operating without modulation or with low modulation?

   Yes - (1) Check microphone and mike cable and plug for open or short.
   (2) Readjust R186 as directed in TRANSMITTER BENCH ALIGNMENT PROCEDURE.
   (3) Check V109 and V110.
   (4) Check voltage and resistance readings at pins of XV109 and XV110 (see voltage-resistance chart).
   (5) Does a 1000 cps signal injected through 0.1-mfd capacitor at TB3-1 produce modulation?

   No - Procede to (6).

   Yes - Check voltages and resistances at XV102-1, 8 and 9.

   (6) Does injection at XV109-6 produce modulation?

   No - Procede to (7).

   Yes - Check C187.

   (7) Does injection at XV109-1 produce modulation?

   No - Procede to (8).

   Yes - Check C182.

   (8) Does injection at XV110-1 produce modulation?

   No - Procede to (9).

   Yes - Check C178.

   (9) Does injection at XV110-6 produce modulation?

   No - Procede to (10).

   Yes - Check C174 and C179.

   (10) Does injection at XV110-7 produce modulation?

   Yes - Check C173.

TYPICAL METERING VOLTAGES

JACK		CIRCUIT	METER READING
MULT-1	J101	Mult-1 Grid (Doubler)	1.0 volt *
MULT-2	J102	Mult-2 Grid (Tripler)	1.0 volt *
MULT-3	J103	Mult-3 Grid (Doubler)	1.0 volt *
PA GRID	J105	PA GRID	1.5 volts *
CATH PA	J106	PA Cathode	1.5 volts

* Minimum meter readings on 6 to 3-volt scale of a 20,000 ohm-per-volt voltmeter.

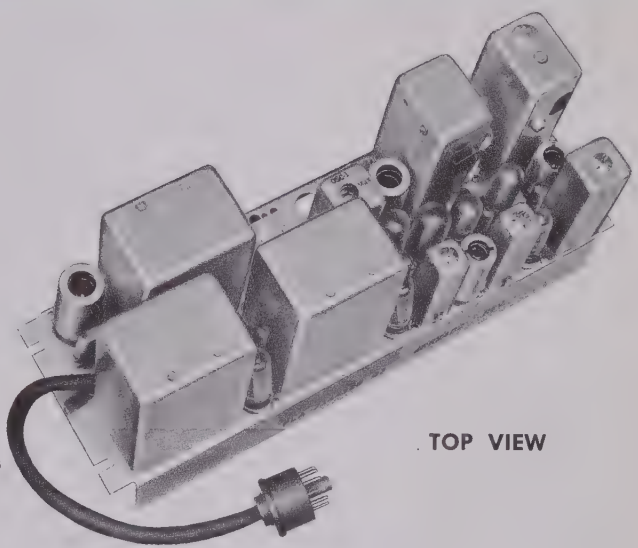
2-WAY MOBILE RADIO

THE PROGRESS LINE

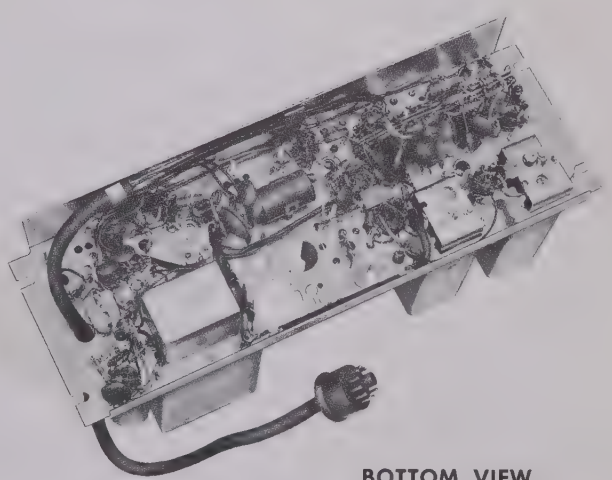
CHASSIS R-1

COMMUNICATION EQUIPMENT

Type	ER-24-A: Narrow band receiver for mobile or station use. ER-24-B: Wide band receiver for mobile or station use.
Frequency range	NARROW BAND: Model No. 4ER24A1: 25-30 megacycles Model No. 4ER24A2: 30-54 megacycles WIDE BAND: Model No. 4ER24B1: 25-30 megacycles Model No. 4ER24B2: 30-54 megacycles
Audio output	1.5 watts (Less than 10% distortion)
Sensitivity	0.4 uv (20 db quieting method)
Squelch	Adjustable, will open at less than 0.15 uv at critical setting
Selectivity	
RETMA method	NARROW BAND (20 kc channels): Adjacent channel 80 db down
20 db quieting method*	100 db ± 16 kc
RETMA method	WIDE BAND (40 kc channels): Adjacent channel 85 db down
20 db quieting method*	100 db ± 30 kc
Band width by swing method of measurement	NARROW BAND: +6 kc at the 6 db points WIDE BAND: ± 15 kc at the 6 db points
Spurious responses	At least 100 db down
Tube complement	6661/6BH6 RF amplifier 6679/12AT7 1st oscillator and converter 6679/12AT7 2nd oscillator and converter 6661/6BH6 low-IF amplifier 6661/6BH6 low-IF amplifier 6661/6BH6 1st limiter 6661/6BH6 2nd limiter 6663/6AL5 discriminator 6663/6AL5 noise rectifier 6661/6BH6 noise amplifier 6681/12AX7 audio amplifier 6AQ5 audio output
Ambient temperature (Outside of cabinet which houses chassis)	− 30°C to + 60°C
Frequency stability over specified temperature range	Unheated crystal: ± 0.002% Heated crystal: ± 0.0005%
Audio frequency characteristics (RETMA method)	Within + 2 to − 8 db of a 6 db/octave de-emphasis curve from 300 to 3000 cps. 1000 cps. reference
Maximum recommended channel separation in 2, 3 or 4 frequency operation	0.4% of operating frequency (approximately 160 kc)
	5¾" high x 4½" wide x 13½" long
	5 lbs.
	*This figure included for comparison purposes only since this method is obsolete.



TOP VIEW

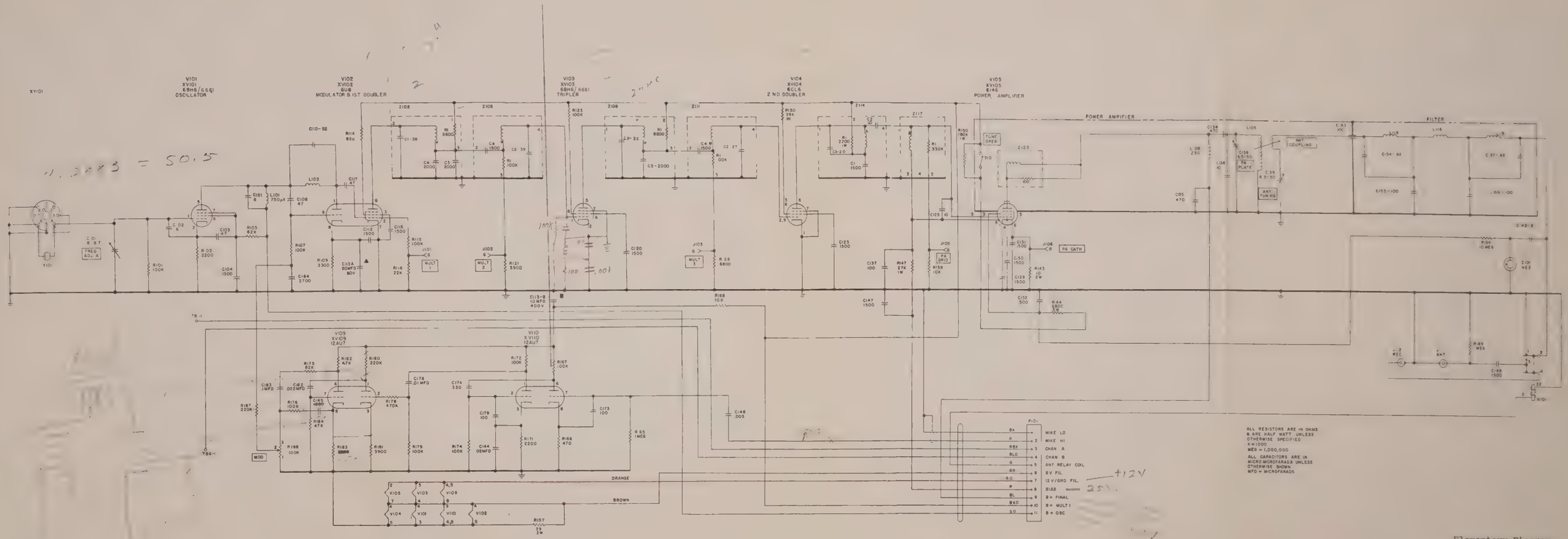


BOTTOM VIEW

The equipment described above meets or exceeds all applicable RETMA specifications.

SCOPE OF SPECIFICATION—In the construction of the equipment described herein, the full intent of the specification will be met. It is assumed, however, that any departure from the specification, desirable for reasons of improved design or operation, will be permissible.

GENERAL ELECTRIC



Elementary Diagram

30-42 MC MOBILE
TRANSMITTER MODEL 4ET22A2

(DD-7669144, Rev. 3)

2-27

DESCRIPTION AND MAINTENANCE INSTRUCTIONS FOR RECEIVER MODEL 4ER24B2

General Electric FM Radio Receiver Model 4ER24B2 is a Progress Line unit designed for operation in Wideband (40KC channel) application on fixed frequencies within the 30 to 54 megacycle range of frequencies. This receiver has been assembled on a 4 1/2 inch x 13 1/2 inch block chassis which mounts directly to the framework of a mobile unit assembly or to the chassis of a rack mounted power supply for station application. Each receiver is directly interchangeable with any other receiver (fixed or mobile) in the same system. Replacement may be accomplished in a matter of minutes by disengaging plug and cable connections and removing the chassis mounting screws.

The Low Band Progress Line Receiver employs a double-conversion super heterodyne circuit with separate crystals, each controlling a conversion frequency. A dual-tuned pre-selector circuit provides maximum protection to the first stage against undesired signals. This receiver employs a 3rd mode crystal in the First Oscillator circuit.

Operating voltages of 200 volts (nominal B+) and 6.6 volts, 13.2 or 26.4 (nominal "A") are derived from a power supply external to the receiver thus permitting fixed/mobile versatility in two-way land mobile communications services. In mobile systems the receiver shares Power Supply Model 4EP2G1 while in fixed systems power is derived from Receiver Power Supply Model 4EP3A1. No change or modification will be required when transferring the unit from service to service since changes in "A" voltages are taken care of by the cable connections to the power supply.

TUBES

The tubes employed in the circuits of this receiver are widely accepted, highly efficient, long life tubes which meet the requirements of mobile and station two-way installations. As communication Type Tubes become available, they are being employed in this receiver and directly replace the standard tube types. Communication type tubes are pre-tested tubes selected specifically to meet the requirements of two-way applications. Communication type tubes are tested for heater cycling reliability, operation at ± 20% of filament ratings and stabilized for a predetermined period of time.

In certain mobile applications, where heavy shock and vibration are regularly encountered, a still more rugged tube may prove more economical. To meet these demands General Electric "Five Star" tubes may be substituted for the Standard or Communication type tubes employed in the circuits of this receiver. "Five Star" tubes are more ruggedly constructed, must pass more rigid tests and are carefully "aged" before packaging. This results in greatly increased life, particularly under the severe vibration and shock conditions sometimes encountered in mobile installations. The Communication Type Tubes and Five Star tubes which are available for use in this receiver are listed below. Check with your tube supplier regarding the availability of those tubes marked with an asterisk.

Standard Tube Type	Communication Tube Type	Five-Star Tube Type
6AL5	6663	GL5726
6AQ5	*	GL6005
6BH6	6661	GL6265
12AT7	*	GL6201
12AX7	*	GL5751

Five-Star tubes are directly interchangeable for 6 or 12-volt operation. In 12-volt applications the heater voltages should be checked at both heater busses since the GL5751 and GL6265 require 0.175 ampere heater current per section; whereas the Standard and Communication types require 0.150 ampere. The extent of unbalance in the heater circuit depends on the number of tubes replaced and location of Five-Star tubes used in the transmitter and receiver. A resistor may be added if required to keep the heaters balanced within this rating. The transmitter heaters must also be considered when checking the filament balance on 12-volt operation.

MAINTENANCE

Inspecting the receiver regularly will assure peak performance and lengthen the life of the equipment. In this way trouble may be anticipated and corrected before operational difficulties arise.

TEST EQUIPMENT

1. A 20,000 ohm-per-volt voltmeter with a 0-3 volt scale or EX-1-C.

2. A 1000 ohm-per-volt A.C. voltmeter.

PROCEDURE

1. The first and most important meter reading is that of the 2nd Limiter on noise. This reading when taken on the 0-3 volt scale of a 20,000 ohm-per-volt meter connected between J303 and ground should not fall below .62 volts (100 microamps on Test Meter EX-1-C). If this value is exceeded, it is likely that the receiver is in good operating condition. If the sensitivity is not normal and the second limiter reads normal, the trouble may be in the antenna or input circuits. If the second limiter current reads appreciably less than specified and tube replacement does not correct the low reading, check the heater and B+ voltages from the power supply. In low band applications the antenna may pick up appreciable noise, depending upon operating location and in mobile application the care used in suppressing noise generated by the vehicle in which the equipment is installed. To evaluate and consider these conditions, remove the antenna and observe the second limiter noise current. Should the location be very noisy it is suggested that the antenna be removed and a resistor of value between 40 and 70 ohms be inserted in place of the antenna before observing the second limiter noise current. In mobile applications be sure the idling speed of the engine is sufficient to put the ammeter on the charge side before making observation.

It is a good practice to record the value of the second limiter noise current or voltage at the time of installation so that it may be used as a reference when making routine service checks. The second limiter current is an accurate measure of the gain from the RF Amplifier tube grid to the Second Limiter grid if the antenna is not picking up appreciable noise voltage.

2. To check Oscillator activity for a weak oscillator tube, refer to the FRONT END TUNING procedures of the RECEIVER BENCH ALIGNMENT PROCEDURE and tune as instructed. If the values given are not obtainable, replace the 12AT7 Oscillator tube.

3. While receiving a weak (LIM reads below limiting) unmodulated signal on the system frequency (exact frequency of transmitter to be monitored), note the meter reading at the DISC meter jack. If the meter reads more than ± 0.2 volt (as read on 4EX2B) and the transmitter is known to be on frequency adjust C320 (OSC 2 crystal trimmer) for zero discriminator reading.

4. Meter the Receiver filament voltage at the power supply. When the source voltage is within proper limits, the filament voltage should fall within ± 10% of the values given below.

Application	Meter Connected Between	Nominal Reading on 0-3 V Scale of 20,000 ohm/volt meter	Corrected Meter Reading or A-C Meter Reading
6 volt Mobile	Inp. V (506)and GND (J508)	0.59 volts d-c 1.29	5.9 volts d-c
12 and 24 volt Mobile	Inp. V (506)and GND (J508)	1.29 volts d-c (12 v) 2.16 volts d-c (24 v)	12.9 volts d-c 21.2 volts d-c
117 volt station	J510-6 and J510-7		6.3 volts d-c

5. Meter the Receiver B-plus at the power supply. When the source voltage is within proper limits, the Receiver B-plus voltage should fall within ± 10% of the value given below.

Measured Between	Reading on 0-3 volt Scale of 20,000 ohm/volt meter	Corrected Meter Reading
LB+ (J505 and GND (J508)	2.0 volts	200 volts

6. If all metering voltages are within tolerance and the Second Limiter noise current is out of tolerance, replace the tubes in the multiplier and RF amplifiers. If tube replacement does not return the Second Limiter current to their nominal limits, check the front end tuning as described in Bench Alignment Procedures.

General Electric Progress Line Receiver Model 4ER24B2 is completely aligned at the factory and set to within .002% of the specified operating frequency. The following chart indicates all tuning procedures required during the life of the equipment. The procedures of columns 3 and 5 should not be attempted and will not improve performance unless modifications have been made or tampering of critical tuning controls has taken place. Under the conditions of guarantee for the receiver, the selectivity of these receivers and the quartz crystals employed in the circuits carries a Life Time Guarantee.

Service Routine	TUNING PROCEDURES				
Circuit To Be Tuned	Upon Installation	Improvement During Service due to tube aging, etc.	Realignment necessitated by tampering Parts repair or replacement	Channel Changing	Channel Splitting
T314(Pre-Selector	A	A	A	A	
T315(R-F)		A	A	A	
C320 (Rubbering trimmer)	F		F	F	F
T316 (High IF)		A	A		
T324 (Low IF)			CDB*		CDB*
T317 (Low IF)			CDB*		CDB*
T306			BD*		
Z305		A	A		
Z302(osc. Plate Tank)			E	E	
T308 (Discriminator)			E		

Tuning Procedure Classification:

*Listed in order of desirability
A Simple peaking for maximum meter reading
B Circuit Loading Method
C Peak and dip method
D Scope Alignment
E Tune according to special instructions
F Use to zero discriminator to system frequency

CIRCUIT ANALYSIS

Receiver Type ER-24-B employs a double-conversion superheterodyne circuit with Intermediate Frequencies of 3.2 megacycles and 290 kilocycles. RF selectivity is accomplished ahead of the RF stage.

Radio Frequency signals received on the antenna are fed to the RF Amplifier grid (XV318-1) through a double tuned pre-selector transformer circuit (T314). This circuit correctly terminates the transmission line, extracts maximum input power from the antenna system and selectively steps up the input voltage of the desired signal as it is transferred from the antenna to the 1st RF grid. Since the double tuned circuits of the pre-selector are very high in Q factor and very selective, accurate tuning to the desired signal is required. The 1st RF Amplifier tube is coupled to the grid of the 1st Converter (1/2 12AT7 low noise triode) by a triple tuned high Q, RF transformer. The plate and tertiary coils of this transformer are inductively coupled and the tertiary and grid coils are capacitively coupled. The high Intermediate Frequency is derived by injecting the oscillator voltage (3.2 megacycles lower in frequency) to the cathode of the 1st Converter, for mixing with the signal.

The injection voltage originates from a 3rd Mode crystal oscillator which utilizes 1/2 of a 12AT7 (V302) with a tuned plate tank (Z302) in a Miller oscillator circuit. Rubbering Receiver Model 4ER24B2 to discriminator "O" is achieved by a ceramic trimmer on the Second Oscillator. The method of frequency rubbering employed in the design of these receivers eliminate the necessity of heated ovens for crystals exposed to the range of ambient temperatures normally encountered. The discriminator secondary should never be adjusted once the IF is aligned.

The 3.2 megacycle high Intermediate Frequency signal derived from the 1st Converter and produced by hetrodyning is fed through a four circuit, highly selective IF transformer (T316) to the 2nd Converter. The plate and first transfer coils are inductively coupled. The first and second transfer coils are high side capacitively coupled while the second transfer and grid coils are inductively coupled.

The output of the selective 3.2 megacycle high IF stage is fed to the 2nd Converter where it is mixed with the 2nd Oscillator injection frequency of 3490 kilocycles producing a 290 kilocycle low IF frequency. High bias of the 2nd Converter stage, resulting from the 47K ohm cathode resistor, greatly reduces desensitization caused by an off frequency signals. A triode Pierce Oscillator circuit is utilized in the 2nd Oscillator stage. A ceramic trimmer capacitor in shunt with the crystal

permits the crystal frequency to be rubbered to compensate for the error or the front end crystal grinding tolerance.

Two six coil low IF transformers are employed in this receiver to obtain the selectivity required for adjacent channel operation and yield the ideal gain for IF Amplifier stages. Each transformer contains six resonant circuits which are alternately inductive and capacitively coupled to each other. Coupling may be reduced or increased to yield the proper selectivity for either wide or narrow band systems. The IF Amplifier band width change requires the addition or deletion of two coupling condensers and changing the spacing of three coils in each of the two transformers.

The first 6 coil low IF transformer, in the plate circuit of the 2nd Converter, selects the 290 kilocycle low IF frequency and provides a high gain, high impedance coupling device. The voltage developed across the grid coil is fed to the grid of the 1st low IF amplifier. A second 6 coil low IF transformer, identical to the first, is used to couple to the 2nd low IF Amplifier (V306) and provides the desired low IF selectivity. The output signal of the 2nd low IF Amplifier is fed through the double tune IF transformer in its plate circuit to the grid of the 6BH6 1st Limiter (V307).

The 1st and 2nd Limiter tubes (V307 and V308) are coupled by a single tuned tank, Z305, whereby sufficient gain for good limiting action is provided. The output of the 2nd Limiter goes directly to the discriminator where the audio voltages are recovered.

The rectified output of the Foster-Seely type discriminator normally serves two purposes. The audio portion of the signal is fed to the Audio Amplifier through a de-emphases network composed of R335, R336, R337, C333 and C336. A rheostat volume control, external to the receiver chassis, is introduced in the circuit at the junction of R335, R336 and R337.

Under no carrier conditions, noise a good portion of which may be due to shot effect and thermal agitation in the first stages of the receiver, is amplified and would ordinarily appear at the loudspeaker as audio noise. To eliminate this, a squelch circuit is introduced. To understand the operation of the squelch circuit, assume no signal is received. The higher frequency components of the noise (above voice frequency range) introduced are coupled to the grid of the noise amplifier. The noise signal is amplified and applied to the noise rectifier, which is a voltage doubler. The rectified noise voltage is divided by a resistor network, and a portion of the voltage developed is applied to the control grid of the squelch tube (V312-2), driving the grid to cathode potential.

This causes plate current to flow, which, in turn, causes a larger drop across the plate resistor. Since the plate resistor is connected to the grid of the Audio Amplifier, the audio amplifier is biased negatively until no plate current flows. Thus, no amplification of the noise takes place and the output does not appear at the loudspeaker.

When a signal is received, the limiters become saturated, noise no longer reaches the discriminator or noise amplifiers, and the voltage output from the noise rectifier disappears. Negative voltage (with respect to ground) from the 2nd limiter is introduced into the noise rectifier circuit, effecting a negative potential at the grid of the squelch amplifier control grid and thus cutting the tube off and allowing the bias voltage of the first audio tube to return to normal.

Audio voltages from the transmitter signal are effectively blocked from the noise amplifier due to the capacitors selected. These capacitors which couple the noise signal to the noise amplifier grid and then to the noise rectifier, are of small value and discriminate against the low audio frequencies so that the audio signal is not amplified to any appreciable extent by the noise amplifier.

Adjustment of the squelch circuit, in order to allow the smallest possible audio signal to render the receiver operative, may be made by a squelch control which is located external to the receiver chassis. This control consists of a rheostat electrically tied to the cathode circuit of the noise amplifier, which varies the gain of the tube by varying its bias.

In operating the equipment, it will be noticed that the squelch does not close immediately when the carrier goes off the air at the end of transmission. A short "burst" of noise will be heard in the loudspeaker at the end of a transmission. The duration of the noise is determined by the time constant established by capacitors C345, C346 and resistor R345. If desired, the duration of the noise signal that breaks through can be shortened considerably by removing capacitor C345. It must be remembered, however, that if this time constant is reduced, weak signals found in the fringe area will be harder to understand since the squelch circuit will react very quickly to variations in signal strength. If the unit is to work in an area where the signals are always strong, the time constant can be reduced with no appreciable effect on intelligibility or operation of the receiver.

BENCH ALIGNMENT PROCEDURE
FOR
RECEIVER MODEL 4ER24B2

In general, the complete procedures of this instruction will not be required in servicing equipment in the field, and should not be attempted unless absolutely necessary. All circuits are stable and precisely aligned at the factory. Touch-up will more likely de-grade performance than improve it.

As described in the DESCRIPTION AND MAINTENANCE Instruction for this Receiver, Receiver Model 4ER24B2 employs a 3rd Mode crystal in the oscillator circuit. The frequency of the receivers may be changed by replacing the 1st oscillator crystal and re-tuning the oscillator and RF stages. The pre-selector trans-former should always be tuned to the operating frequency.

The discriminator and low frequency amplifiers should never be retuned in the field, unless it is definitely known that the adjustments have been tampered with or circuits have been altered. In high selectivity receivers, the walls of the pass-band curve of the IF amplifier system are very steep and the discriminator "zero" or target must be in the center of the pass-band to give proper operation. Distortion will occur where the FM signal is hitting either sidewall of the low IF pass band. Centering of the discriminator in the low IF band is accomplished at the factory by aligning the discriminator on a 290-kilocycle crystal controlled signal source. The IF sweep generator is then centered on the discriminator zero for the IF tuning.

Alignment of even the double-tuned IF stage T306 should be scrupulously avoided in the field unless it is known that it has been tampered with or misaligned. Since the nose of the low IF pass band is fairly flat, and the second limiter is saturated on noise, peaking of IF circuits on an RF signal or noise is entirely unsatisfactory as a method of alignment.

Where a transmitter signal known to be on the correct frequency does not give a discriminator reading within ± 0.2 volt of zero (on 0-3 volt scale 20,000 ohm-per-volt meter) or 1 volt (on VTVM), adjust the second oscillator trimmer (C302).

For all the following procedures, signals from the generator should be applied through a .01 mfd capacitor using leads as short as possible for the capacitor and probe ground. The ground connection of the generator probe should be at a point on the receiver chassis, as close to the point of signal input as possible.

RECEIVER BENCH ALIGNMENT PROCEDURE

NOTE

During the entire alignment, the generator frequency must be maintained at zero discriminator (after the discriminator has been correctly set at 290 kilocycles). The input may be at any point ahead of the transformer being tuned, but the level must be reduced to prevent saturation. Always use the most sensitive meter scale and reduce the input accordingly.

When checking that the generator is still on discriminator zero (this should be checked every few minutes), use a signal which just saturates the second limiter grid. A lower signal level should be used for tuning all IF transformers, so that the second limiter grid is not saturated (less than 15 vdc on XV308-1, in most receivers or 0.5 volt on 0-3 voltmeter at J303).

DISCRIMINATOR ALIGNMENT

When it has been definitely determined that the discriminator has been misadjusted or tampered with, the following alignment procedure may be used:

EQUIPMENT REQUIRED

1. A screw driver.

2. A 0-3 volt 20,000 ohm-per-volt voltmeter or a d-c vacuum tube voltmeter, a G-E Test Set EX-1-C or 100 microampere meter can be used, if desired.

3. A 290-kilocycle calibrated signal source, or access to the transmitted signal that will normally be received.

4. Oscilloscope recommended but not required.

Z305 Alignment (Where Necessary):

Apply a 290-kilocycle ± .002% unmodulated carrier to the grid of the 1st limiter tube XV-307 pin #1 thru a .01-mfd capacitor and tune Z-305 (in the plate circuit of the 1st limiter) for maximum second limiter grid reading at J-303 (LIM-2). (Note: input signal must not produce limiting for tuning. Signal should produce less than 15 volts d-c at second limiter grid or 0.5 volt on 0-3 volt meter at J303). Receiver and signal source should warm-up sufficiently to avoid drift in frequency. Five minutes should be sufficient for the receiver, but some signal generators may require over half an hour before stabilizing in frequency.

PROCEDURE

1. Apply a 290-kilocycle signal through a .01-mfd capacitor to pin #1 of XV307. (See preceding section if Z305 must be realigned). Connect the voltmeter between the DISC jack (J304-orange) and the GND jack (J508-black, on the power supply chassis).

2. Remove crystal Y304 (3490-kilocycle crystal) to prevent noise or RF signals from interfering with the alignment.

3. Adjust the Secondary (top slug) tuning of the discriminator (T308) for zero discriminator reading. (This signal must develop at least 32 volts d-c at pin #1 of XV308 or 1.15 volts on 0-3 volt meter at J303, that is produce limiting.)

4. Apply a signal from an alignment sweep generator, if available, to the 1st limiter grid and set the unmodulated carrier for zero discriminator reading, using a saturation signal as in the preceding step. Apply modulation (60-cycle, 100-kilocycle deviation) and, with a scope attached at J-304, observe the discriminator picture. Tune the primary, if necessary, for linearity of slope and symmetry.

5. If a sweep generator is unavailable, apply an unmodulated signal from a signal generator on which it is possible to read 290 kc and 290 kc + and -10kc unmodulated carrier. The plus and minus voltages developed by the discriminator for plus and minus 10 kc from 290 kc should be identical within about 0.3 volts (2 percent of higher reading) and should each be within about 10% of 12 volts (VTVM) or 2.0 volts on EX-2-B. To obtain equal plus and minus voltages for ± 10-kilocycle, adjust the primary (bottom slug) tuning of the discriminator. Recheck the secondary tuning, since any appreciable movement of the primary affects the secondary. The reverse is also true; if the secondary is moved 0.5 kilocycles or more, the primary should be retuned. It is suggested that the smaller of the plus and minus discriminator voltages be observed while changing the primary tuning.

NOTE

Wherever possible the discriminator of the receiver should be zeroed on 290 kilocycles, rather than on a transmitter which might be somewhat off frequency.

IF ALIGNMENT

Under normal conditions, the receiver will not require a complete realignment. However, if modifications are made in the low frequency stages, or if unauthorized persons tamper with the transformer tuning controls, the following procedure is recommended.

The 2nd limiter noise current was 110 microamperes (0.66 volts on 0-3 volt meter) or more when shipped. No loss of sensitivity of the receiver will occur as the tubes age, until the noise current drops below 100 microamperes on EX-1-C (.62 volts on 0-3 scale of 20,000 ohm-per-volt meter). An increase in noise current at the first limiter grid, obtained by tuning the preselector or RF transformer, will increase sensitivity. Any receiver in which the preselector and RF transformer have been peaked, and in which the antenna has been replaced with a 50-ohm load, will have normal sensitivity if the 2nd limiter current is 110 microamperes (0.66 volts on 0-3 volt meter) or more. Many receivers may have noise currents much higher than this, but the unusually high noise currents do not necessarily indicate a better sensitivity.

The chart below will be useful for isolating a defective stage when the receiver is not operating properly. If the input signal is adjusted to give 40 microamperes (.33 volt on 0-3 volt meter) of 1st limiter current when the receiver is being checked on the service bench, the input signal required at the various points will be approximately as follows:

37.2 MC R.F. Grid	3.20 M.C. 1st Mixer	290 kc 2nd Mixer	290 kc IF_1 XV-305-1	290 kc IF_2 XV-306-1
14	85	320	1350	100,000

All readings in microvolts

An input to the 1st Limiter grid of 80,000 microvolts will produce 40 microamperes at the Second Limiter grid.

In the following procedure, it is assumed that the discriminator transformer has not been tampered with. If it appears evident that the transformer is misaligned, oscilloscope tuning is recommended. If an oscilloscope is not available, a signal generator procedure may be used (See DISCRIMINATOR ALIGNMENT). Since the discriminator is used to determine the exact frequency, it should be zeroed on an accurate 290-kilocycle signal or, if necessary, on a transmitter which is known to be on the correct frequency, before tuning the low IF amplifier.

EQUIPMENT REQUIRED

1. A screw driver.

2. A stable signal generator, covering the necessary frequencies for the section to be tuned. A weak, unmodulated signal from the transmitter with which the receiver will be used can be substituted for the 25 to 50 megacycle signal generator. A Measurements Corporation Model 80, a Boonton 202-C and Univerter, Marconi TF-913 or Marconi TF-1066, or a New London Model 100 C may be used to provide the 25 to 50 megacycle signal for front end alignment.

3. A discriminator meter (a d-c VTVM, an EX-1-C, a 0-100 microampere meter, or a 0-3 volt 20,000 ohm-per-volt meter).

4. A good sweep generator and oscilloscope are necessary to align the 290-kilocycle IF transformers properly. The sweep generator may be a Boonton 202-C with a Univerter and a 60-cycle external sweep-voltage transformer. A double trace, synchronized at 120 cycles, is desirable for all IF tuning.

290-KC IF ALIGNMENT PROCEDURES

Crystal Y304 (3490 kilocycles) should be removed to prevent RF or noise signals from interferring with alignment.

T306 Sweep Method

The alignment of Z305 is described in the first subsection of the DISCRIMINATOR ALIGNMENT section. To align T306, attach a scope at J302. Apply the sweep generator to pin #1 of XV306. After setting the unmodulated carrier frequency to give zero discriminator reading, set the deviation for 60 kilocycles. Align the top and bottom slugs of T306 to make the bottom and sides of the picture coincide. Refer to the typical scope picture illustrated in Fig. 1 on the next page.

Move the scope to J303. Reduce the generator input and retouch Z305 and T306 to make the side walls and bottom of the trace on the scope coincide.

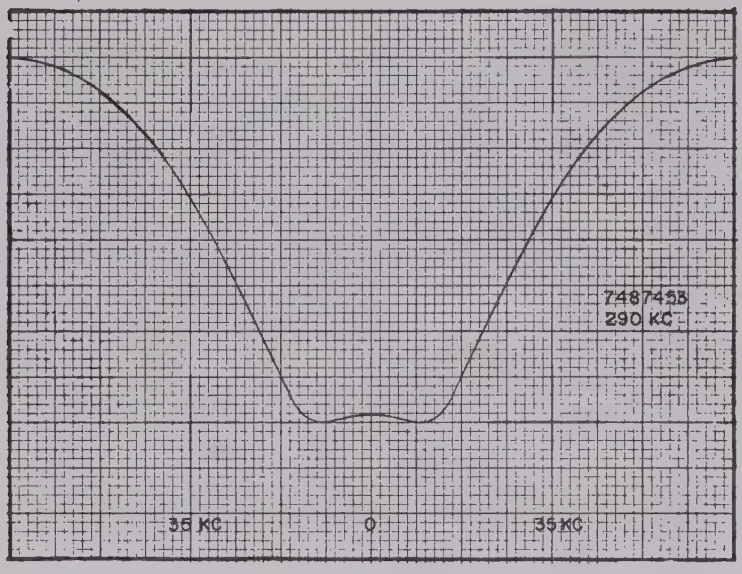


Fig. 1 - Scope Picture of T306

T306 Resistor Load Method

The double tuned gain stage transformer can be tuned by resistance loading of the transformer. Load the primary with 68,000 ohms and connect the meter to J-302 and generator input at pin #1 of XV-306. Tune the primary and then the secondary or bottom slug for maximum limiter current. Use as small a input signal as possible. Remove the resistor from the primary.

T317 Peak and Dip Method

Transformer T317 is readily tuned by using the peak and dip method. Using this method, only the IF voltage across the plate tank circuit need be metered. Tuning is accomplished by tuning one circuit at a time (from plate coil to grid coil) while observing the meter and with the circuit following the one being tuned shorted out. The grounding points are located just adjacent to the tuning studs. The tuning studs are oriented in order of circuit sequence; the stud for coil L1 is located at the lower left portion of the transformer structure and the stud for coil L6 is located at the lower right. The intermediate coil tuning studs (L2, L3, L4, L5, and L6) are then located in consecutive clockwise order from L1 to L6.

Connect an RF vacuum tube voltmeter to the plate of the 1st low IF Amplifier (XV305-5) through an isolating capacitor. The VTVM used may be any instrument not employing a selenium rectifier since these are usually intended for 60 cycles or audio frequencies only. Should the VTVM be low in impedance use a 3 to 5 mmf capacitor in series with it to prevent loading the circuit. If desired, the meter may be inserted in the eyelet adjacent to the tuning stud for L1, being careful not to short the meter probe to the slot. This metering point is isolated from B+. Apply a 290 kilocycle signal to pin 1 of XV305 being careful to zero this signal to the discriminator. Short L2 to entrance slot and tune L1 tuning stud for maximum deflection of VTVM (use most snesitive scale of VTVM - not more than 0-10 V scale). Remove short from L2, short L3 to entrance slot and tune L2 tuning stud for a dip in tuning meter. Remove short from L3, short L4 to entrance slot and tune L3 tuning stud for maximum deflection of tuning meter. Remove short from L4, short L5 to entrance slot and tune L4 tuning stud for a dip. Remove short from L5, short L6 to entrance slot and tune L5 tuning stud for maximum deflection. Remove short from L6 and tune L6 tuning stud for minimum deflection of the meter. Remove the VTVM from the circuit and load L2 by inserting a 68,000 ohm, 1/2 watt resistor in the L2 eyelet, grounding the other end. Connect a meter to the limiter jack, J302. While keeping the 1st Limiter current below 100 microamperes (1.0 volt on 0-3.0 volt scale of 20,000 ohm/volt meter EX2B1) tune L1 for a maximum deflection of the meter. Remove the loading resistor and replace the transformer cover.

If a sweep is available, the scope picture of the six coil transformer should look like Fig. 2 illustrated on the next page. Note: Even if a sweep set-up for alignment is available, use the peak and dip method before trying to make tuning adjustment with scope tuning. The peak and dip method is fool proof. If the circuits are far out of alignment, sweep and scope tuning may only be used after the peak and dip method.

The six coil transformer can also be tuned using resistance loading; however, the peak and dip method is preferred.

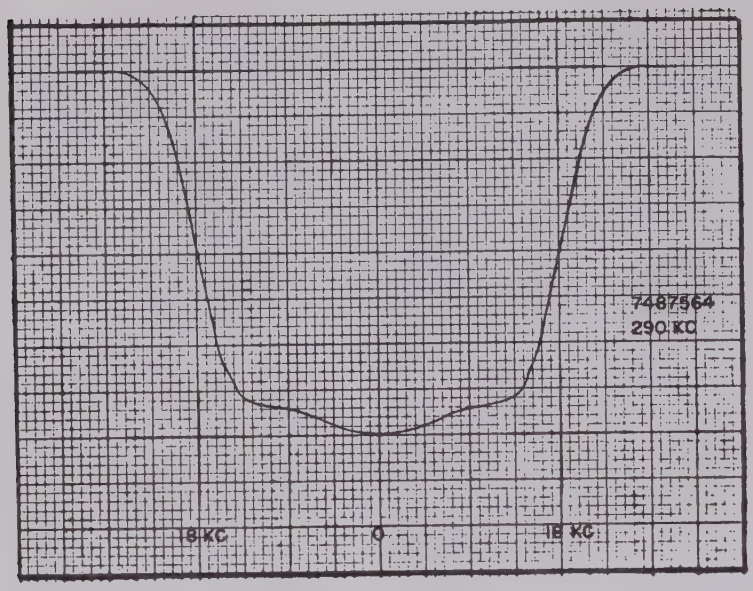


Fig. 2 - Scope Picture of T317 and T324

T324 Peak and Dip Method

Low IF transformer T324 may be tuned while following the procedure for tuning transformer T317. Transformer T324 and T317 are identical in construction.

Connect the Vacuum Tube Voltmeter through a blocking capacitor to the plate of the 2nd Converter (if desired, the meter may be inserted in the eyelet adjacent to the tuning stud for L1, being careful not to short the meter probe to the slot. This metering point is isolated from B+).

Feed an unmodulated 290 kilocycle signal to XV319-2 (with 2nd Osc. crystal removed) being careful to zero the signal to the discriminator. Observe the VTVM and adjust the signal input so that the meter tracks with the output level of the generator. Short L2 to entrance slot and tune L1 tuning stud for maximum deflection of the VTVM (use most sensitive scale). Remove short from L2, short L3 to entrance slot and tune L2 tuning stud for a dip. Remove short from L3, short L4 to entrance slot and tune L3 tuning slug for maximum meter deflection. Remove short from L4, short L5 to entrance slot and tune L4 tuning stud for dip. Remove short from L5, short L6 to entrance slot and tune L5 tuning stud for maximum meter reading. Remove short from L6 and Tune L6 tuning stud for minimum meter deflection.

Remove VTVM from circuit and load L2 by inserting 68,000 ohm, 1/2 watt resistor in L2 eyelet, grounding the other end. While keeping the First Limiter below 100 microamperes (1.0 volts on 0-3 volt scale of 20,000 ohm/volt meter) tune L1 to a maximum deflection of the meter. Remove the loading resistor and replace transformer cover.

If a sweep generator and scope are available refer to figure 2 for checking the visual alignment.

3.2 - MC IF ALIGNMENT PROCEDURES

To properly align T316, apply a stable, unmodulated signal to pin 7 of XV302, being careful to zero this signal to the discriminator with a Saturation Signal at the Second Limiter. Tune the four coils of T316 for maximum LIM-1 current, using a meter at the LIM-1 jack (J302-negative). Do not saturate the First Limiter. Leave the Second Oscillator crystal in place for this procedure.

DISCRIMINATOR IDLING

When a set has been completely and properly aligned, the no signal (noise only) reading of the discriminator should be within ± 0.6 volts (VTVM) of 0. This is equivalent to 10.0 microamperes in 2400 ohm microammeter or 0.2 volts on 20,000 ohm-per-volt meter. Set the 0 by adjusting the grid coil (T316-4), accessible through the adjustment hole in the side of the outer can of transformer T316.

FRONT END TUNING

The frequency of the receiver may be changed by replacing the 1st oscillator crystal and retuning the oscillator, and RF stages as described below. If the receiver needs to be completely retuned, use the procedures outlined in the foregoing portion of this instruction.

EQUIPMENT REQUIRED

1. A non-metallic screw driver.

2. A 20,000 ohm-per-volt voltmeter with a 0-3 volt scale.

3. A crystal of the proper frequency for the first oscillator (mode crystal - between 26.8 MC and 50.8 MC). Crystal frequency = Operating frequency = 3.2 MC.

4. A signal generator with a 25-50 megacycle range such as a Measurements Corporation Model 80, a Boonton 202-C and Univerter, a Marconi TF-913, a Marconi TF-1066 or New London Model 100C. If a generator is not available when tuning the receiver in the field, connect the proper antenna to the receiver and transmit a weak signal from the transmitter with which the receiver is intended to operate.

PROCEDURE

Meter readings listed below are to be taken between the jacks indicated and ground.

NOTE

For tuning ceramic trimmers, use dot of solder on ceramic part of rotor as a pointer for indicating maximum or minimum. When the mounting screws of trimmer are not visible, the maximum or minimum position will be marked on the housing in which the capacitor is mounted. Where mounting screws are visible, maximum capacity will be realized when the pointer lies toward the mounting screws on the perpendicular to a line joining the two mounting screws. Minimum capacity will then be attained by rotating rotor 180 degrees.

1. Turn the receiver on and allow it to warm up for five minutes. Be sure that the battery voltage is normal (6.6, 13.2 or 26.4 volts d-c.

2. Insert the First Oscillator crystal in the First Oscillator crystal socket.

3. Connect a 0-3 volt meter equivalent to 4EX2B1 or EX1C to the OSC-1 jack, J305 (green-negative).

4. Retract (turn to left) Z302 tank tuning slug (accessible from underside of chassis) until the slug is three full turns from end of travel.

5. Tune for peak activity as follows:

a. For front end frequencies less than 37 megacycles, set C-1 of Z302 (trimmer at top of tank assembly) for maximum capacity and move tuning slug in for peak activity as noted on meter (peak reading).

b. For front end frequencies above 37 megacycles, adjust trimmer Z302-C1 (trimmer at top of tank assembly) for peak activity as noted on meter (peak reading).

6. After tuning for peak detune from the peak by rotating tank tuning slug (Z302-L1) counterclockwise until the meter reads 50% of the maximum grid current but not less than 0.22 volts, whichever is greatest. If this cannot be obtained repeat steps 5 and 6 after retracting slug 4 or 5 turns from end of travel. It is desirable to always tune down from peak oscillator current using the slug as this makes it possible to be certain that the plate circuit is tuned higher in frequency. The trimmer rotates 360° therefore it is difficult to judge direction of tuning when the trimmer is used. When the slug is turned to the left the plate tank is always tuned higher in frequency and this is the correct direction in which to tune when tuning down from oscillator peak current.

RF and Antenna Transformer

1. Connect signal generator to pin 1 of XV318. With generator adjusted to zero discriminator and output below limiting, peak the three circuits of T315. Care must be exercised in peaking the third tuned circuit of T315 (C7 and L13 located from underside of chassis) as in some instances the circuit can be tuned to the crystal frequency. For operating frequencies above 37 megacycles retract the slug of L3 (turn slug all way to left) and tune T315-C7 for maximum First Limiter current (largest peak). For frequencies below 37 megacycles turn trimmer to maximum capacity (using dot of solder on ceramic rotor of trimmer as the pointer) and tune T315-L3 for maximum First Limiter current (larger peak). Use the same procedure for tuning T315-L2 and T315-C4 of the second circuit and T315-L1 and T315-C1 of the first circuit.

2. Move signal generator to antenna jack (J1 on antenna transformer). Use 50 ohm T pad (or equivalent) of Signal Generator accessories for a dummy antenna.

3. With meter at LIM-1 (J302) and signal on operating frequency applied, peak antenna transformer (T314) trimmers C1 and C3 (top and bottom of housing).

4. Recheck the RF and multiplier tuning. If possible monitor an unmodulated signal from a system transmitter for this check using the system antenna to pick up the signal.

a. Recheck the tuning of Z302 (meter connected to J305, OSC.).

b. Recheck the adjustment for discriminator "O" (trimmer C320 on Second Oscillator).

c. With meter connected to J302, LIM-1, recheck the peaking of C1 and C3 of T314.

d. With meter connected to J302, LIM-1, recheck the peaking of T315.

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
C316		Capacitor, fixed, Ceramic dielectric; Hi-K disk, 0.02 mfd +80% -20%, 450 v d-c w.	2nd Converter cathode by-pass.
C319		Capacitor, fixed, Paper dielectric; hermatically sealed, oil filled, 0.04 mfd ±20%, 400 v d-c w.	2nd converter screen by-pass.
C320		Capacitor, variable, Ceramic dielectric; 5 to 20 mmfd, 500 v d-c w.	2nd osc. plate load.
C321		Same as C316.	B+ by-pass.
C322		Same as C316.	1st low IF cathode by-pass.
C323		Same as C319.	1st low IF screen by-pass.
C325		Same as C319.	2nd low IF screen by-pass.
C326		Same as C316.	2nd low IF cathode by-pass.
C327		Capacitor, fixed, Ceramic dielectric; Hi-K disk, 0.01 mfd +80% -20%, 450 v d-c w.	1st limiter meter by-pass.
C328		Same as C319.	1st limiter screen by-pass.
C329		Same as C327.	2nd limiter meter by-pass.
C330		Same as C316.	Squelch by-pass.
C331		Same as C319.	2nd limiter screen by-pass.
C332		Capacitor, fixed, Ceramic dielectric; stabilized Hi-K disk, 220 mmfd ±10%, 500 v d-c w.	Discriminator cathode by-pass.
C334		Capacitor, fixed, mica dielectric; Class C dipped phenolic insulation, 1000 mmfd ±10%, 500 v d-c w.	Audio deemphasis.
C337		Capacitor, fixed, Ceramic dielectric; temp compensating, disk, 100 mmfd ±10%, 500 v d-c w, -750 temp coef.	Noise amp. grid filter.
C338		Capacitor, fixed, Ceramic dielectric; temp compensating, disk, 47 mmfd ± 10%, 500 v d-c w, -750 temp coef.	Noise amp. grid coupling.
C339		Same as C316.	Noise amp. cathode.
C340		Same as C316.	Noise amp. screen.
C341		Same as C337.	Noise amp. plate.
C342		Same as C337.	Noise rect.coupling.
C343		Capacitor, fixed, Ceramic dielectric; stabilized Hi-K disk, 3300 mmfd ± 10%, 500 v d-c w.	Noise rect. filter.
C344		Same as C343.	Noise rect. filter.
C345		Same as C327.	DC Amp. grid.
C346		Same as C316.	DC Amp. grid.
C347A		Capacitor, fixed, electrolytic; tubular, 5 mfd +100% -10%, 150 v d-c w. Part of 2 section electrolytic.	Cathode by-pass audio amp.
C348		Capacitor, fixed, mica dielectric; Class C, dipped phenolic insulation, 3900 mmfd ±10%, 500 v d-c w.	Power amp. grid.
C349		Same as C316.	B+ by-pass.
C350		Capacitor, fixed, Ceramic dielectric; stabilized Hi-K disk, 5100 mmfd ±10%, 500 v d-c w.	Power Amp. plate.
C351		Same as C350.	Power Amp. plate.
C354		Same as C316.	Heater by-pass.
C355		Same as C316.	Heater by-pass.
C358		Capacitor, fixed, ceramic dielectric; stabilized Hi-K disk, 1500 mmfd ±10%, 500 v d-c w.	RF Amp. cathode by-pass.

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
C359		Same as C358.	RF Amp. screen by-pass.
C361		Same as C327.	1st Converter cathode by-pass.
C362		Same as C327.	1st Converter plate by-pass.
C367		Same as C316.	Heater by-pass.
C368		Same as C316.	Heater by-pass.
C371		Same as C327.	Heater by-pass.
C378		Same as C316.	1st osc. cathode freq. B.
C379		Same as C316.	1st osc. cathode freq. B.
C381		Capacitor, fixed, plastic dielectric; molded phenolic, 2.2 mmfd ± 0.11 mmfd, 500 v d-c w.	2nd osc. injection.
C382		Capacitor, fixed, Ceramic dielectric; temp compensating, tubular, 22 mmfd ±5%, 500 v d-c w, -80 temp coef.	1st converter plate load.
C388		Same as C345.	Audio Coupling.
C389		Same as C345.	Audio Deemphasis.
C390		Same as C358.	DC Amp.plate by-pass.
J302		Jack, tip; Test point jack, phenolic or urea.	1st limiter grid.
J303		Same as J302.	2nd limiter grid.
J304		Jack, tip; Test point, jack, phenolic or urea.	Discriminator.
J305		Same as J302.	1st oscillator tuning
L304		Coil, radio frequency; 5.6 uh ±10%.	Filament choke.
L305		Same as L304.	Filament choke.
P301		Connector, plug, electrical; part of W301.	Power 2nd control.
R302		Resistor, fixed, composition; 330 ohms ±10%, 1/2 w.	RF cathode.
R310		Resistor, fixed, composition; 0.10 megohms ±10%, 1/2 w.	2nd oscillator grid.
R312		Resistor, fixed, composition; 47,000 ohms ±10%, 1/2 w.	2nd converter cathode
R313		Resistor, fixed, composition; 0.47 megohm ±10%, 1/2 w.	2nd converter grid bleeder.
R314		Resistor, fixed, composition; 0.12 megohm ± 10%, 1/2 w.	2nd converter plate.
R315		Resistor, fixed, composition; 0.68 megohm ±10%, 1/2 w.	1st low IF grid.
R316		Resistor, fixed, composition; 220 ohms ±10%, 1/2 w.	1st low IF cathode.
R317		Resistor, fixed, composition; 22,000 ohms ±10%, 1 w.	1st low IF plate.
R320		Same as R316.	2nd low IF cathode.
R321		Same as R317.	2nd low IF plate.
R323		Resistor, fixed, composition; 0.20 megohms ±5%, 1/2 w.	1st limiter grid.
R324		Resistor, fixed, composition; 18,000 ohms ±10%, 1/2 w.	1st limiter meter.
R325		Resistor, fixed, composition; 18,000 ohms ±10%, 2 w.	1st limiter plate.
R326		Resistor, fixed, composition; 3900 ohms ±10%, 1/2 w.	2nd limiter plate.
R327		Same as R323.	2nd limiter grid.
R328		Resistor, fixed, composition; 12,000 ohms ±10%, 1/2 w.	2nd limiter meter.
R329		Resistor, fixed, composition; 1.0 megohms ±10%, 1/2 w.	Squelch coupling.
R330		Resistor, fixed, composition; 33,000 ohms ±10%, 1/2 w.	2nd limiter plate bleeder.
R331		Same as R310.	Disc. load.
R332		Same as R310.	Disc. load.

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R334		Resistor, fixed, composition; 0.22 megohms ±10%, 1/2 w.	Disc. meter.
R335		Same as R334.	Audio deemphasis.
R336		Same as R315.	Audio deemphasis.
R337		Resistor, fixed, composition; 0.33 megohms ±10%, 1/2 w.	Audio decoupling.
R338		Same as R310.	Noise Amp. coupling.
R339		Same as R310.	Noise Amp. grid.
R340		Resistor, fixed, composition; 0.39 megohm ±10%, 1/2 w.	Noise Amp. cathode bleeder.
R341		Resistor, fixed, composition; 1000 ohms ±10%, 1/2 w.	Noise amp. cathode.
R342		Resistor, fixed, composition; 0.27 megohms ±10%, 1/2 w.	Noise amp. screen.
R343		Same as R310.	Noise amp. plate.
R344		Same as R310.	Noise amp. filter.
R345		Same as R329.	DC Amp. grid.
R346		Same as R329.	Noise rect. load.
R347		Same as R329.	Noise rect.decoupling.
R348		Resistor, fixed, composition; 0.56 megohms ±10%, 1/2 w.	Squelch divider.
R350		Same as R310.	Audio amp. cathode bleeder.
R351		Resistor, fixed, composition; 22,000 ohms ±10%, 1/2 w.	Audio amp. cathode.
R352		Resistor, fixed, composition; 560 ohms ±10%, 1/2 w.	Audio amp. cathode.
R353		Resistor, fixed, composition; 2.7 megohm ±10%, 1/2 w.	DC Amp. plate.
R355		Same as R334.	Audio amp. plate.
R356		Same as R313.	Power amp. grid.
R357		Resistor, fixed, composition; 270 ohms ±10%, 1 w.	Power amp. cathode.
R358		Same as R334.	Oscillator grid.
R360		Same as R351.	Oscillator metering.
R366		Same as R337.	2nd oscillator plate dropping.
R367		Resistor, fixed, composition; 56,000 ohms ±10%, 1/2 w.	RF amp. screen dropping.
R368		Resistor, fixed, composition; 2200 ohms ±10%, 1/2 w.	1st mixer cathode.
R369		Same as R315.	2nd low IF grid.
R370		Resistor, fixed, composition; 82,000 ohms ±10%, 1/2 w.	1st converter plate.
R371		Same as R302.	Oscillator cathode.
R375		Resistor, fixed, composition; 10,000 ohms ±10%, 1/2 w.	2nd converter plate load.
R377		Same as R312.	1st low IF plate load.
R381		Same as R329	RF amp. grid return.
R385		Same as R312.	1st converter plate loading.
R397		Same as R334.	Audio Amp. grid.
T306		Transformer, intermediate frequency.	290 KC 3rd low IF.
T306-C1		Capacitor, fixed, ceramic dielectric; temp compensating, disk, 62 mmfd ±5%, 500 v d-c w, -80 temp coef.	
T306-C2		Capacitor, fixed, ceramic dielectric; temp compensating, disk, 27 mmfd ±5%, 500 v d-c w, -150 temp coef.	
T306-C3		Capacitor, fixed, ceramic dielectric; temp compensating, disk, 62 mmfd ±5%, 500 v d-c w, -80 temp coef.	

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
T306-R1		Resistor, fixed, composition; 82,000 ohms ±10%, 1/2 w.	
T308		Transformer, discriminator;	290 KC discriminator Audio output.
T308-C1		Capacitor, fixed, ceramic dielectric; temp compensating, 68 mmfd 2-1/2%, 500 v d-c w, -80 temp coef.	
T308-C2		Capacitor, fixed, ceramic dielectric; temp compensating, tubular,120 mmfd ±5%, 500 v d-c w, -80 temp coef.	
T308-C3		Capacitor, fixed, ceramic dielectric; temp compensating, tubular, 47 mmfd ±5%, 500 v d-c w, -80 temp coef.	
T308-R1		Resistor, fixed, composition; 10,000 ohms ±10%, 1/2 w.	
T309		Transformer, audio frequency; pri imp 5200 ohms ±10%, with 3.5 ohm resistive load on sec.	Audio output.
T314		Transformer, radio frequency;	Antenna transformer.
T314-C1		Capacitor, variable, air dielectric; 4.4 to 50 mmfd, screw driver slot.	
T314-C2		Capacitor, fixed, ceramic dielectric; temp compensating, tubular, 15 mmfd ±5%, 500 v d-c w, -80 temp coef.	
T314-C3		Capacitor variable, air dielectric; 4.4 to 50 mmfd, screw driver slot.	
T314-C4 and T314-C7		Capacitors, fixed, ceramic dielectric; temp compensating, tubular, 10 mmfd ± 5 mmfd, 500 v d-c w, -80 temp coef.	
T314-C8		Capacitor, fixed, ceramic dielectric; temp compensating, tubular, 30 mmfd ±5%, 500 v d-c w, -80 temp coef.	
T314-C9		Capacitor, fixed, ceramic dielectric; temp compensating, tubular, 33 mmfd ±5%, 500 v d-c w, -80 temp coef.	
T314-J1		Jack, tip; phono type, mica filled phenolic.	
T315		Transformer, radio frequency;	Plate of RF Amp,V318.
T315-C1		Capacitor, variable, ceramic dielectric; 4.75 to 45 mmfd, 500 v d-c w, -500 ± 200 temp coef.	
T315-C2		Capacitor, fixed, mica dielectric; 2200 mmfd ±10%, 300 v d-c w.	
T315-C4 and T315-C7		Capacitor, variable, ceramic dielectric; 4.75 to 45 mmfd, 500 v d-c w, -500 ±200 temp coef.	
T315-C9		Capacitor, fixed, silver mica dielectric; CM15 case, 330 mmfd ±10%, 500 v d-c w.	
T315-C10		Capacitor, fixed, ceramic dielectric; temp compensating, tubular, 15 mmfd ±5%, 500 v d-c w, -80 temp coef.	
T315-C11		Capacitor,fixed, ceramic dielectric; temp compensating, tubular, 24 mmfd ±5%, 500 v d-c w, -80 temp coef.	
T315-C12		Capacitor, fixed, ceramic dielectric; temp compensating, tubular, 20 mmfd ±5%, 500 v d-c w, -80 temp coef.	
T315-C16		Capacitor, fixed, plastic dielectric; molded phenolic, 0.75 mmfd ± 0.05 mmfd, 500 v d-c w.	
T315-R1		Resistor, fixed, composition; 10,000 ohms ±10%, 1 w.	
T315-R2		Resistor, fixed, composition; 47,000 ohms ±10%, 1/2 w.	
T316		Transformer, intermediate frequency;	High IF (3.2 mc).

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
T316-C1		Capacitor, fixed, ceramic dielectric; temp compensating, 82 mmfd ± 2-1/2%, 500 v d-c w, -80 temp coef.	
T316-C5		Capacitor, fixed, ceramic dielectric; disk, temp compensating, 120 mmfd ±5%, 500 v d-c w, -80 temp coef.	
T316-C6		Capacitor, fixed, silver mica dielectric; CM15 case, 220 mmfd ±10%, 500 v d-c w.	
T316-C7		Capacitor, fixed, ceramic dielectric; temp compensating, tubular, 33 mmfd ±5%, 500 v d-c w, -80 temp coef.	
T316-C8 and T316-C9		Capacitors, fixed, ceramic dielectric; temp compensating, disk, 47 mmfd ±5%, 500 v d-c w, -80 temp coef.	
T316-C10		Capacitor, fixed, plastic dielectric; molded phenolic, 0.82 mmfd ±5%, 500 v d-c w.	
T316-R1		Resistor, fixed, composition; 47,000 ohms ±10%, 1/2 w.	
T317		Transformer, Intermediate frequency;	290 KC 2nd low IF.
T317-C2		Capacitor, fixed, ceramic disk dielectric; temp compensating, 100 mmfd ± 2-1/2%, 500 v d-c w, -80 temp coef.	
T317-C3		Capacitor, fixed. ceramic dielectric; temp compensating, 7.25 mmfd ± 0.20 mmfd, 500 v d-c w, -80 ± 60 temp coef.	
T317-C4 and T317-C5		Capacitors, fixed, ceramic dielectric; temp compensatin ,disk, 100 mmfd ± 2-1/2%, 500 v d-c w, -80 temp coef.	
T317-C6		Capacitor, fixed, ceramic,dielectric; temp compensating, 6.0 mmfd ± 0.20 mmfd, 500 v d-c w, -80 ± 60 temp coef.	
T317-C7 and T317-C8		Capacitors, fixed, ceramic dielectric; temp compensating, disk 100 mmfd ± 2-1/2%, 500 v d-c w, -80 temp coef.	
T317-C9		Capacitor, fixed, silver mica dielectric; CM15 case, 330 mmfd ± 10%, 500 v d-c w.	
T317-C10 and T317-C11		Capacitors, fixed, ceramic dielectric; temp compensating, disk, 100 mmfd ± 2-1/2%, 500 v d-c w, -80 temp coef.	
T317-R1		Resistor, fixed, composition; 47,000 ohms ± 10%, 1/2 w.	
T317-R2		Resistor, fixed, composition; 0.47 megohms ± 5%, 1/2 w.	
T324		Transformer, intermediate frequency;	290 KC lst low IF.
T324-C1		Capacitor, fixed, silver mica dielectric; CM15 case, 510 mmfd ± 300 v d-c w.	
T324-C2		Capacitor, fixed, ceramic dielectric; temp compensating disk, 100 mmfd ± 2-1/2%, 500 v d-c w, -80 temp coef.	
T324-C3		Capacitor, fixed, ceramic dielectric; temp compensating, 7.25 mmfd ± 0.20 mmfd, 500 v d-c w, -80 ± 60 temp coef.	
T324-C4 and T324-C5		Capacitors, fixed, ceramic dielectric; temp compensating, disk 100 mmfd ± 2-1/2%, 500 v d-c w, -80 temp coef.	
T324-C6		Capacitor, fixed, ceramic dielectric; temp compensating, 6.0 mmfd ± 0.20 mmfd, 500 v d-c w, -80 ± 60 temp coef.	
T324-C7 and T324-C8		Capacitors, fixed, ceramic dielectric; temp compensating, disk, 100 mmfd ± 2-1/2%, 500 v d-c w, -80 temp coef.	

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
T324-C9		Capacitor, fixed, silver mica dielectric, CM15 case, 330 mmfd ± 10%, 500 v d-c w.	
T324-C10		Capacitor, fixed, ceramic dielectric; temp compensating, disk, 100 mmfd ± 2-1/2%, 500 v d-c w, -80 temp coef.	
T324-R1		Resistor, fixed, composition; 47,000 ohms ± 10%, 1/2 w.	
T324-R2		Resistor, fixed, composition; 0.47 megohms ± 5%, 1/2 w.	
V302		Electron Tube; type 12AT7.	1st converter.
V305		Electron Tube; type 6BH6.	1st low IF amp.
V306		Same as V305.	2nd low IF amp.
V307		Same as V305.	1st limiter.
V308		Same as V305.	2nd limiter.
V309		Electron Tube, type 6AL5.	Discriminator.
V310		Same as V305.	Noise Amp.
V311		Same as V309.	Noise rect.
V312		Electron Tube, type 12AX7.	Squelch amp,audio amp.
V313		Electron Tube, type 6AQ5.	Audio power amp.
V318		Same as V305.	RF Amp.
V319		Same as V302.	2nd oscillator and converter.
W301		Cable, special purpose, electrical; includes molded connector with 11 male contacts, connector, color green.	Power and control cable.
XV302		Socket, electron tube; includes shield, mica filled phenolic, 9 pin miniature.	1st converter tube socket.
XV305		Socket, electron tube; includes shield, mica filled phenolic, 7 pin miniature top mount, flat top.	1st low IF tube socket.
XV306		Same as XV305.	2nd low IF tube socket.
XV307		Socket, electron tube; includes shield, mica filled phenolic, 7 pin miniature, top mount, flat top.	1st limiter tube socket.
XV308		Same as XV305.	2nd limiter tube socket.
XV309		Same as XV307.	Discriminator tube socket.
XV310		Same as XV305.	Noise amp. tube socket.
XV311		Same as XV305.	Noise rect. tube socket.
XV312		Socket, electron tube; mica filled phenolic, 9 pin miniature, saddle type, top mount.	Audio amp. squelch tube socket.
XV313		Same as XV305.	Power Amp. tube socket.
XV318		Same as XV307.	RF tube socket.
XV319		Same as XV302.	2nd Oscillator and converter tube socket.
XY303		Socket, crystal; 2 pin steatite type CR-7.	1st oscillator.
XY304		Same as XY303.	2nd oscillator.
Y303		Crystal unit, quartz; 2 pin, freq range 21 to 51 mc/s on 3rd mode, low freq 21 to 28 mc/s, inter freq 30 to 35 mc/s, high freq 37 to 51 mc/s, Specify exact frequency when re-ordering.	1st oscillator.
Y304		Crystal Unit, quartz; 3490 KC ± 100 cps, oper temp range -30° to +95°C.	2nd oscillator.
Z302		Oscillator Subassembly; 1st osc. tank.	1st oscillator tank.

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
Z302-C1		Capacitor, variable, ceramic dielectric; 4.5 to 45 mmfd, 500 v d-c w, -500 ± 200 temp coef.	
Z302-C2		Capacitor, fixed, mica dielectric; 220 mmfd ± 10%, 300 v d-c w. RETMA Type RCM20B.	
Z302-C3		Capacitor, fixed, ceramic dielectric; temp compensating, tubular, 10.0 mmfd ± 0.5 mmfd, 500 v d-c w, -80 temp coef.	
Z302-C4		Capacitor, fixed, ceramic dielectric; temp compensating, tubular, 47 mmfd ± 5%, 500 v d-c w, -80 temp coef.	
Z302-R1		Resistor, fixed, composition; 8200 ohms ± 10%, 1/2 w.	
Z305		Tank, gain stage tank.	4th low IF.
Z305-C1 and Z305-C2		Capacitors, fixed, ceramic dielectric, temp compensating, disk, 27 mmfd ± 5%, 500 v d-c w, -150 temp coef.	

STOCK NUMBER IDENTIFICATION
RECEIVER MODEL 4ER24B2

Ref. Symbol	General Electric Part Number	Manufacturer's Part Number		Stock Number
C 316	B-7488160-P2	CN Type DA-145		For Replacement use SNSN N16-C019143-4001
C 319	K-7131023-P4	CLD	*	N16-C043904-9072
C 320	M-7484389-P4	ERC Type TS2A-N300		N16-C064012-1363
C 327	B-7488160-P1	CM Type DA-048		For Replacement use SNSN N16-C019111-1141
C 332	C-3R81-P221K	RAMT Type JL	**	N16-C017726-5483
C 334	A-7147203-P108	EMM Type DM-20	**	N16-C031090-3782
C 337	C-7774846-P621	SPR Type 29C	**	N16-C017086-2634
C 338	C-7774846-P617	SPR Type 19C	**	N16-C016542-5278
C 343	C-3R81-P332K	RAMT Type JL	**	N16-C018920-1004
C 347	B-7488699-P1	MAL	*	N16-C021442-1005
C 348	A-7147203-P122	EMM Type DM-20	**	N16-C032435-6774
C 350	C-3R81-P512K	RAMT Type JL	**	N16-C019011-5910
C 358	C-3R81-P152K	RAMT Type JL	**	N16-C018782-8784
C 381	K-7130348-P4	JFE Type JM 5/32	**	N16-C055551-3469
C 382	P-7770468-P247	ERC Style 331	**	N16-C016146-6682
J 302	A-7143966-P4	APDP Type 110BCS-green		N17-J039985-3554
J 304	A-7143966-P8	APDP Type 110BCS-orange		N17-J039980-4937
*L 304	B-7488079-P40	JFE Cat. #10203-20		N16-C071581-4703
R 302	C-3R77-P331K	IRC Type BTS	**	N16-R049706-0761
R 310	C-3R77-P104K	IRC Type BTS	**	N16-R050633-0785
R 312	C-3R77-P473K	IRC Type BTS	**	N16-R050479-0440
R 313	C-3R77-P474K	IRC Type BTS	**	N16-R050822-0761
R 314	C-3R77-P124K	IRC Type BTS	**	N16-R050651-0818
R 315	C-3R77-P684K	IRC Type BTS	**	N16-R050894-0813
R 316	C-3R77-P221K	IRC Type BTS	**	N16-R049661-0818
R 317	C-3R78-P223K	AB Type GB	**	N16-R050373-0238
R 323	C-3R77-P204J	IRC Type BTS	**	N16-R050704-0380
R 324	C-3R77-P183K	IRC Type BTS	**	N16-R050354-0815
R 325	C-3R79-P183K	AB Type HB	**	N16-R050355-0498
R 326	C-3R77-P392K	IRC Type BTS	**	N16-R050093-0816
R 328	C-3R77-P123K	IRC Type BTS	**	N16-R050309-0816
R 329	C-3R77-P105K	IRC Type BTS	**	N16-R050975-0725
R 330	C-3R77-P333K	IRC Type BTS	**	N16-R050417-0823
R 334	C-3R77-P224K	IRC Type BTS	**	N16-R050714-0818
R 337	C-3R77-P334K	IRC Type BTS	**	N16-R050759-0818
R 340	C-3R77-P394K	IRC Type BTS	**	N16-R050786-0818
R 341	C-3R77-P102K	IRC Type BTS	**	N16-R049922-0730
R 342	C-3R77-P274K	IRC Type BTS	**	N16-R050741-0818
R 348	C-3R77-P564K	IRC Type BTS	**	N16-R050858-0818
R 351	C-3R77-P223K	IRC Type BTS	**	N16-R050372-0833
R 352	C-3R77-P561K	IRC Type BTS	**	N16-R049805-0818
R 353	C-3R77-P275K	IRC Type BTS	**	N16-R051092-0818
R 357	C-3R78-P271K	AB Type GB	**	N16-R049689-0238
R 367	C-3R77-P563K	IRC Type BTS	**	N16-R050516-0818
R 368	C-3R77-P222K	IRC Type BTS	**	N16-R050012-0816
*P 301				For Reference Only

STOCK NUMBER IDENTIFICATION
RECEIVER MODEL 4ER24B2

Ref. Symbol	General Electric Part Number	Manufacturer's Part Number		Stock Number
R 370	C-3R77-P823K	IRC Type BTS	**	N16-R050588-0818
R 375	C-3R77-P103K	IRC Type BTS	**	N16-R050282-0725
T 306	PL-7487453-G3	GE		N17-T067556-7147
T 306-C1	C-7774846-P258	ERC Style 811	**	For Reference only
T 306-C2	C-7774846-P349	ERC Style 801	**	For Reference only
T 306-C3	C-7774846-P258	ERC Style 811	**	For Reference only
T 306-R1	C-3R77-P823K	IRC Type BTS	**	For Reference only
T 308	PL-7774567-G1	GE		N17-T067119-5951
T 308-C1	P-7772250-P229	ERC Style 337	**	For Reference only
T 308-C2	P-7770468-P265	ERC Style 838	**	For Reference only
T 308-C3	P-7770468-P255	ERC Style 831	**	For Reference only
T 308-R1	C-3R77-P103K	IRC Type BTS	**	For Reference only
T 309	B-7487281-P1	NYT	*	N17-T062640-5947
T 314	PL-7487297-G1	GE		N16-C071581-4702
T 314-C1	B-7485440-P7	JON Type K	**	For Reference only
T 314-C2	P-7770468-P244	ERC Style 331	**	For Reference only
T 314-C3	B-7485440-P7	JON Type K	**	For Reference only
T 314-C4	P-7770468-P210	ERC Style 331	**	For Reference only
T 314-C8	P-7770468-P250	ERC Style 331	**	For Reference only
T 314-C9	P-7770468-P251	ERC Style 331	**	For Reference only
T 314-J1	K-7104941-P7	CIN Cat. #14K12699		For Reference only
T 315	PL-7488612-G2	GE		N17-T081267-5951
T 315-C1	M-7484389-P7	ERC Style TS-2A	**	For Reference only
T 315-C2	M-7478981-P4	EMM Type RCM20B222K		For Reference only
T 315-C4	M-7484389-P7	ERC Style TS-2A	**	For Reference only
T 315-C9	P-3R122-P24	EMM Type CM-15	**	For Reference only
T 315-C10	P-7770468-P244	ERC Style 331	**	For Reference only
T 315-C11	P-7770468-P248	ERC Style 331	**	For Reference only
T 315-C12	P-7770468-P246	ERC Style 331	**	For Reference only
T 315-C16	K-7130348-P2	JFE Type JM 5/32	**	For Reference only
T 315-R1	C-3R78-P103K	AB Type GB	**	For Reference only
T 315-R2	C-3R77-P473K	IRC Type BTS	**	For Reference only
T 316	PL-7487563-G4	GE		N17-T067811-5951
T 316-C1	P-7772250-P231	ERC Style 831	**	For Reference only
T 316-C5	C-7774846-P265	ERC Style 826	**	For Reference only
T 316-C6	P-3R122-P22	EMM Type CM-15	**	For Reference only
T 316-C7	P-7770468-P251	ERC Style 331	**	For Reference only
T 316-C8	C-7774846-P255	ERC Style 816	**	For Reference only
T 316-C10	K-7130348-P12	JFE Type JM 5/32	**	For Reference only
T 316-R1	C-3R77-P473K	IRC Type BTS	**	For Reference only
T 317	PL-7487564-G2	GE		N17-T067569-5964
T 317-C2	C-7774970-P221	ERC Style 826	**	For Reference only
T 317-C3	B-7488184-P3	ERC Style 332	**	For Reference only
T 317-C4	C-7774970-P221	ERC Style 826	**	For Reference only
T 317-C6	B-7488184-P2	ERC Style 332	**	For Reference only
T 317-C7	C-7774970-P221	ERC Style 826	**	For Reference only
T 317-C9	P-3R122-P24	EMM Type CM-15	**	For Reference only

STOCK NUMBER IDENTIFICATION
RECEIVER MODEL 4ER24B2

Ref. Symbol	General Electric Part Number	Manufacturer's Part Number		Stock Number
T 317-C10	C-7774970-P221	ERC Style 826	**	For Reference only
T 317-R1	C-3R77-P473K	IRC Type BTS	**	For Reference only
T 317-R2	C-3R77-P474J	IRC Type BTS	**	For Reference only
T 324	PL-7487564-G4	GE		N17-T067569-5952
T 324-C1	P-3R122-P64	EMM Type CM-15	**	For Reference only
T 324-C2	C-7774970-P221	ERC Style 826	**	For Reference only
T 324-C3	B-7488184-P3	ERC Style 332	**	For Reference only
T 324-C4	C-7774970-P221	ERC Style 826	**	For Reference only
T 324-C6	B-7488184-P2	ERC Style 332	**	For Reference only
T 324-C7	C-7774970-P221	ERC Style 826	**	For Reference only
T 324-C9	P-3R122-P24	EMM Type CM-15	**	For Reference only
T 324-C10	C-7774970-P221	ERC Style 826	**	For Reference only
T 324-R1	C-3R77-P473K	IRC Type BTS	**	For Reference only
T 324-R2	C-3R77-P474J	IRC Type BTS	**	For Reference only
V 302		GE Type 12AT7		N16-T058240-0010
V 305		GE Type 6BH6		N16-T056213-0020
V 309		GE Type 6AL5		For Replacement use SNSN N16-T075726-0000
V 312		GE Type 12AX7		N16-T058241-0060
V 313		GE Type 6AQ5		For Replacement use SNSN N16-T076005-0004
W 301	A-7144728-P1	CMS Cat. #1601-M11		N17-C048658-9538
XV 302	M-7480532-P3	EBY Type TSE9T201		N16-S064063-6538
XV 305	P-7768887-P2	EBY Cat. #9726-10		N16-S062598-5395
XV 307	P-7768887-P9	EBY Type TSE7T201		N16-S062603-6659
XV 312	A-7144667-P1	EBY Cat. #9739-8		N16-S064063-1740
XY 303	K-7128948-P1	EBY Cat. #9006		N16-S054287-5051
Y 303	B-7489151-P1	GE		*F16-C099401-1157
Y 304	A-7142762-P2	GE		N17-C096965-1614
Z 302	PL-7488739-G1	GE		N16-C071581-4713
Z 302-C1	M-7484389-P7	ERC Style TS2A	**	For Reference only
Z 302-C2	M-7478981-P4	EMM Type RCMB20	**	For Reference only
Z 302-C3	P-7770468-P210	ERC Style 331	**	For Reference only
Z 302-C4	P-7770468-P255	ERC Style 331	**	For Reference only
Z 302-R1	C-3R77-P822K	IRC Type BTS	**	For Reference only
Z 305	PL-7488108-G2	GE		N16-C071581-4711
Z 305-C1	C-7774846-P349	ERC Style 801	**	For Reference only
Z 305-R2	C-3R77-P104K			For Reference only

* This part has been manufactured to meet General Electric Purchase Specifications. When ordering from the manufacturer, order by General Electric Part Number.

** When ordering this part from the manufacturer, specify type and information included under name and description.

Block Diagram

30-54 MC RECEIVER
MODEL 4ER24B2

(RC-358 Mod.)

VOLTAGES FROM TUBE SOCKET PINS TO CHASSIS ±10%

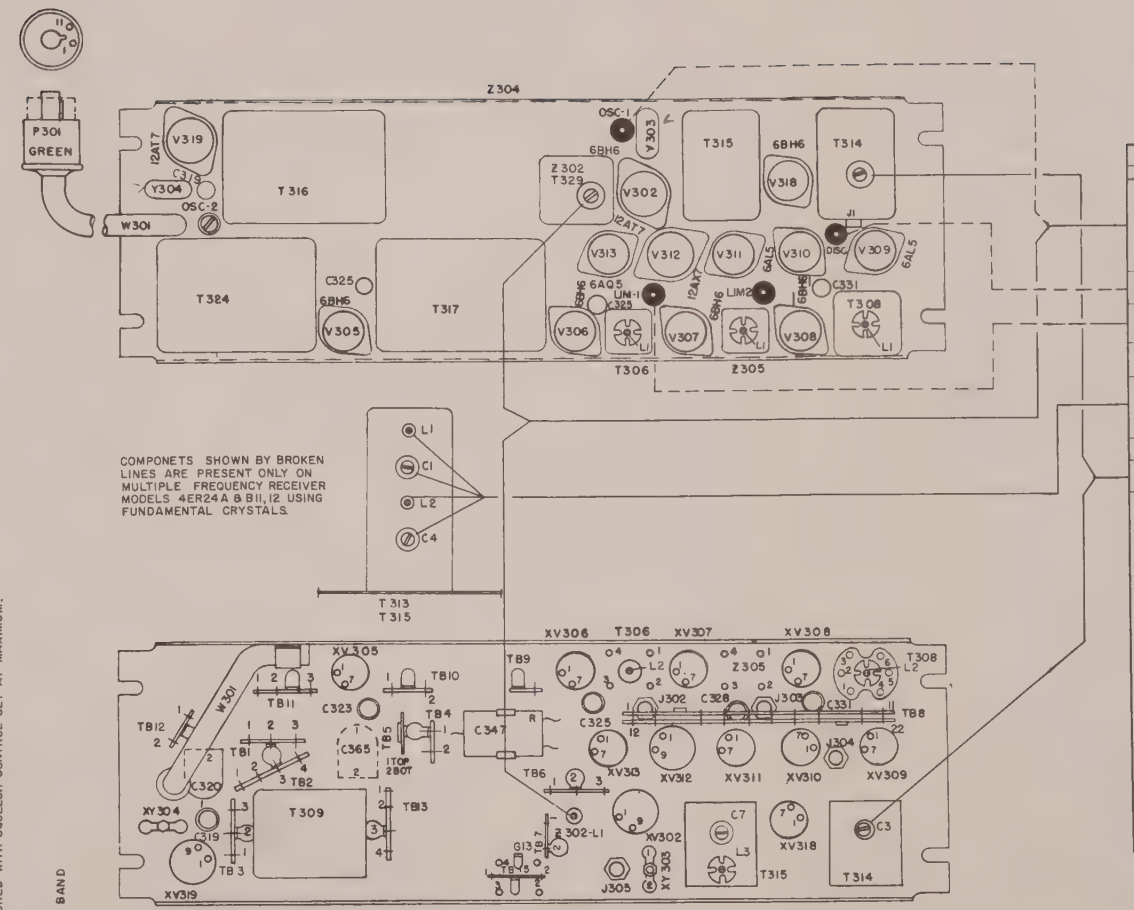
RESISTANCE FROM TUBE SOCKET PINS TO CHASSIS ±20%

9	8	7	6	5	4	3	2	1	SYMBOL	TUBE TYPE	1	2	3	4	5	6	7	8	9
6.3	3.0	0	120	0	0/12.9	1.3	-2.8	165	XV302	12AT7				FIL.	FIL.	80K	48K	2.6K	FIL.
—	—	0	95 N 100 W	95 N 100 W	0	6.3	1.0	0	XV305	6BH6	40K	220	FIL.	FIL.	222K-N 69K W	22K	0	—	—
—	—	0	95	95	6.3	0/12.9	1.0	0	XV306	6BH6	42K	220	FIL.	FIL.	22K	22K	0	—	—
—	—	0	85	85	0	6.3	0	-0.4 -1.0VT	XV307	6BH6	220K	0	FIL.	FIL.	12K	12K	0	—	—
—	—	0	70	70	0	6.3	0	-28 -36VT	XV308	6BH6	180K	0	FIL.	FIL.	13K	13K	0	—	—
—	—	-35 -21VT	0	0	6.3	0	-12 -20VT	-0.3	XV309	6AL5	66K	70K	FIL.	FIL.	0	0	72K	—	—
—	—	0	85 90VT	95 100VT	0/12.9	6.3	2.0 5.0VT	0	XV310	6BH6	180K-N 100K-W	1K	FIL.	FIL.	100K	270K	0	0	—
—	—	-1.0 -13.0VT	0	-0.2 -11.0VT	0/12.9	6.3	-0.5 -9.0VT	-0.5 -9.0VT	XV311	6AL5	INF	INF	FIL.	FIL.	2MEG	0	1.2M-N 1.5M-W	—	—
6.3	40.0	.75 26.0VT	190	0	0/12.9	0	-0.7 -3.5VT	0.6 27.0VT	XV312	12AX7	2.7MEG	3MEG	0	FIL.	FIL.	220K	3.4MEG	18K	FIL.
—	—	0	120	165	0 -	6.3	1.5	0	XV318	6BH6	1MEG	330	FIL.	FIL.	10K	56K	0	—	—
6.3	0	-12.0	40	0	0/12.9	15.0	12.0	125 M 130 W	XV319	12AT7	160K-N 150K-W	40K	47K	FIL.	FIL.	270K	100K	0	FIL.

READINGS ARE TYPICAL VOLTAGES MEASURED ON A 20,000 OHM-PER-VOLT VOLTMETER (UNLESS OTHERWISE SPECIFIED) WITH POWER APPLIED TO THE RECEIVER. ALL MEASUREMENTS ARE MADE WITH A METER RANGE THAT GIVES BETWEEN APPROXIMATELY ONE-THIRD AND FULL-SCALE DEFLECTION. READINGS FOLLOWED BY "VT" WERE OBTAINED WITH A HIGH IMPEDANCE VACUUM TUBE VOLTMETER.
① MEASURED WITH SQUELCH CONTROL SET AT MAXIMUM.

READINGS ARE TYPICAL RESISTANCES MEASURED WITH ALL POWER REMOVED FROM RECEIVER AND WITH ALL VOLTAGE SOURCES DISCONNECTED. THE POWER CONTROL CABLE (W301) IS CONNECTED AND ALL TUBES ARE IN PLACE.

W WIDE BAND



SIMPLIFIED ALIGNMENT PROCEDURE

The following instructions cover the procedure for retuning the oscillator and RF stages of the receiver. If it is desired to completely realign the receiver, use the procedure outlined in the RECEIVER BENCH ALIGNMENT PROCEDURE. If the receiver is to operate on two frequencies which are more than 200 kilocycles apart, the RF amplifier and multipliers should be tuned to the receiver mid-frequency for the best sensitivity.

PRELIMINARY OPERATIONS

1. Be sure that a crystal of the proper frequency is in the first oscillator crystal socket.
2. Turn the power on and allow 5 minutes for warmup.

METERING JACK —	METERING JACK +	TUNING CONTROL	METER READING	PROCEDURE
OSC-1 J305 green	GND	R302-C1 and L1	50% of Maximum (at least 0.22 volt or 15 microamps)*	1A. Turn R302 tuning slug (beneath chassis) out counterclockwise to within 3 turns of end of travel. For front end frequency above 37 MC, peak R302-C1 (top of transformer) or for front end frequency below 37 MC, set R302-C1 for maximum capacity and peak R302-L1 clockwise. Detune R302-L1 counterclockwise to 50% of maximum meter reading, but not less than 0.22 volt (15 microamps).
DISC J304 orange		Adjust frequency of signal generator.	Zero	2. Connect signal generator at XV318-1. Using maximum generator output, zero generator to discriminator. This zeroing should coincide with an increase in LIM-1 voltage.
LIM-1 J302 green			Increase	
		Generator voltage	Below saturation, but above noise.	3. Reduce generator output until LIM-1 Meter indicates below saturation, but above noise.
		T315	Maximum	4. For operating frequencies above 37 MC, rotate T315-L3 fully counterclockwise and peak T315-C7. For frequencies below 37 MC, set T315-C7 at maximum capacity and peak T315-L3. Use same procedure for tuning T315-L2 and C4 and T315-L1 and C1.
				5. Move signal generator to antenna jack (J1 on antenna transformer).
		Antenna Transformer T314-C1 and C3 (top and bottom trimmers)	Maximum	6. Peak T314.
				7. Remove signal generator.
				8. Recheck RF and multiplier tuning, while receiving unmodulated signal from one of transmitters receiver is to monitor.
				9. Recheck zeroing of discriminator by adjusting C320.
				10. Repeak T314-C1 and C3 (see Step 6).
				11. Recheck tuning of R302.
				12 Repeak T315.

*Meter readings are obtained with a 20,000 ohm-per-volt voltmeter or a 0-500 ua meter, such as the G-E Test Set Type EX-1-C

_____ SOLID LINES INDICATE TUNING CONTROLS.

- - - - - BROKEN LINES INDICATE METERING JACKS.

Service Outline

30-54 MC RECEIVER
MODEL 4ER24B2

(RC-355A Mod.)

HINTS FOR SERVICING

The following list of service hints, in addition to the Table of Typical Metering Voltages and the voltage-resistance chart (see reverse side of page) will assist the serviceman in locating the source of trouble if the Receiver should fail to operate properly.

PRELIMINARY CHECKS

The serviceman should first measure the LIM-1 and LIM-2 voltages and compare the readings with those recorded when the receiver was installed. A similar meter reading indicates that the RF and IF stages are operating properly.

SYMPTOMS	SERVICE CHECKS
No filament or B-plus voltage.	Check connection of control cable to Power Supply.
	Refer to SERVICE OUTLINE for receiver Power Supply.
Low filament or B-plus voltage.	Check for defect in B-plus or filament circuit causing excess current drain. Check plug to Power Supply.
	Refer to SERVICE OUTLINE for receiver Power Supply.
LIM-1 and LIM-2 readings low.	Check B-plus voltages.
	Check tubes in RF and IF stages.
No crystal oscillator output indicated by low meter reading at OSC-1 jack (J305).	Test oscillator tube.
	Check B-plus voltage.
	Tune Z302 (see SIMPLIFIED ALIGNMENT PROCEDURE on reverse side of page).
	Check to see if crystal holding clip is shorting out test prod.
Low sensitivity, but normal readings at LIM-1 and LIM-2 jacks.	Check external antenna circuit.
	Tune antenna transformer (T314) and RF transformer (T315) as outlined in SIMPLIFIED ALIGNMENT PROCEDURE on reverse side of page.
No audio.	Disable squelch by removing 6AL5 Noise Rectifier or 6BH6 Noise amplifier. If audio breaks through, an unbalance exists in the squelch circuit.
	Short 6AQ5 cathode momentarily to ground. If loud click is not heard in speaker, look for defect in output transformer or voice coil leads. If loud click is heard, short 12AX7 audio section to ground. If loud click is not heard, check coupling capacitor and B-plus voltage.
Squelch will not open.	In stations, check muting relay on Power Supply.
	Test V310, V311 and V312. Check LIM-2 grid voltage.
	Check socket voltages (see Voltage-Resistance Chart on reverse side of page).
Intermittent reception.	Check for overdeviation of transmitter.
	Check to see if narrow-band receiver is being used in wide-band system.

TYPICAL METERING VOLTAGES

METER JACK		CIRCUIT	METER READING	
			VOLTMETER*	MICROAMMETER**
LIM-1	J302	1st Limiter grid	0	0
LIM-2	J303	2nd Limiter grid	At lease 0.72 volt	125 microamp
DISC	J304	Discriminator (Do not touch top or bottom trimmers of discriminator unless IF amp is aligned to new frequency).	While receiving signal on system frequency, adjust OSC-2 trimmer to bring DISC reading as close to zero as possible (should not exceed 15 microamp).	
OSC-1	J305	1st Oscillator grid	0.22 volt (minimum)	15 microamp (minimum)

*Typical meter readings on 0 to 3-volt scale of a 20,000 ohm-per-volt voltmeter.

**Typical meter readings on a General Electric Test Set Type EX-1-C or an equivalent microammeter having an internal resistance of 2500 ohms (50 or 100 ua scale) or 250 ohms (500 ua scale).

2-WAY MOBILE RADIO

THE PROGRESS LINE

CHASSIS PV-3A

COMMUNICATION EQUIPMENT

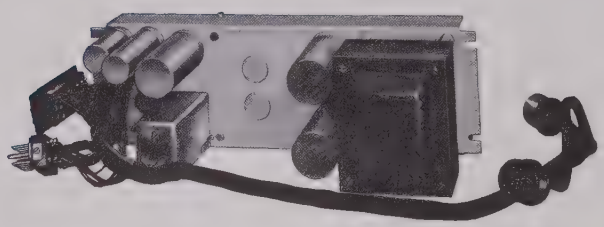
Type EP-2-G

Description Power supply for medium power mobile unit.

Nominal input voltage 6, 12 or 24 volts d-c

Current drain (maximum)

	STANDBY	TRANSMIT
6 volt	10.0 amps	33.5 amps
12 volt	5.8 amps	17.3 amps
24 volt	3.6 amps	9.5 amps



TOP VIEW

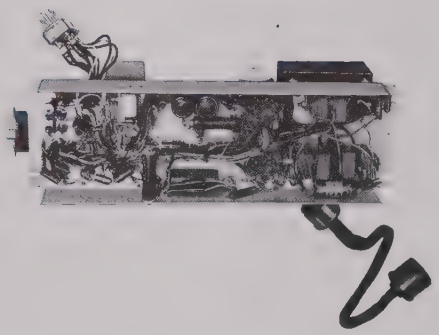
Output voltage

To transmitter:

425 volts at 150 milliamperes
300 volts at 120 milliamperes
200 volts at 10 miliamperes
−25 volts bias

To receiver:

197 volts at 85 milliamperes



BOTTOM VIEW

Used with Chassis T-13 (transmitter Type ET-22-A) and Chassis R-1 (receiver Type ER-24-A or ER-24-B) 25-54 megacycles
Chassis T-33 (transmitter Type ET-20-A) and Chassis R-3 (receiver Type ER-25-A or ER-25-B) 144-174 megacycles.

Type of circuit Tapped, full-wave bridge using transformer, split-reed, dual-interrupter type vibrator, and G-E industrial type 45-volt, high-temperature selenium rectifier cells.

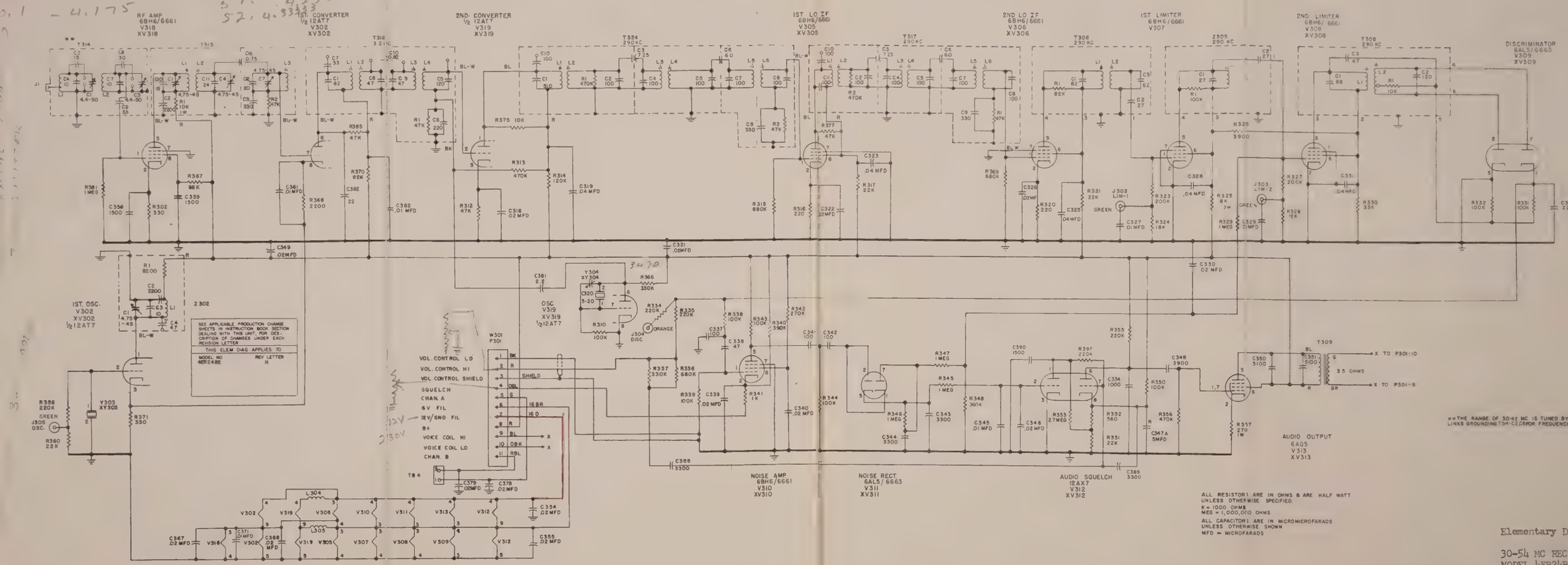
Size 13½" long x 6" high x 4¼" wide.

Weight 12 lbs.

The equipment described above meets or exceeds all applicable RETMA specifications. Technical data is on file with, and the equipment is acceptable for licensing by, the FCC.

SCOPE OF SPECIFICATION—In the construction of the equipment described herein, the full intent of the specification will be met. It is assumed, however, that any departure from the specification, desirable for reasons of improved design or operation, will be permissible.

GENERAL ELECTRIC


RF AMP 6BH6/6661 V318 XV318
1ST. CONVERTER ½ 12AT7 V302 XV302
2ND. CONVERTER ½ 12AT7 V319 XV319
1ST LO IF 6BH6/6661 V305 XV305
2ND LO IF 6BH6/6661 V306 XV306
1ST LIMITER 6BH6/6661 V307
2ND LIMITER 6BH6/6661 V308
DISCRIMINATOR 6AL5/6663 V309 XV309
IST. OSC. V302 XV302 ½ 12AT7
OSC V319 XV319 ½ 12AT7
NOISE AMP. 6BH6/6661 V310 XV310
NOISE RECT. 6AL5/6663 V311 XV311
AUDIO SQUELCH 12AX7 V312 XV312
AUDIO OUTPUT 6AQ5 V313 XV313
VOL. CONTROL LO
VOL. CONTROL HI
VOL. CONTROL SHIELD
SQUELCH
CHAN. A
6V FIL
12V/GND FIL
B+
VOICE COIL HI
VOICE COIL LO
CHAN. B
SHIELD
12V
21.30V
SEE APPLICABLE PRODUCTION CHANGE SHEETS IN INSTRUCTION BOOK SECTION DEALING WITH THIS UNIT, FOR DESCRIPTION OF CHANGES UNDER EACH REVISION LETTER
THIS ELEM DIAG APPLIES TO
MODEL NO 4ER24B2
REV LETTER N
** THE RANGE OF 30-42 MC IS TUNED BY CLIPPING THE LINKS GROUNDING T314-C22,28 FOR FREQUENCIES ABOVE 38 MC.
ALL RESISTORS ARE IN OHMS & ARE HALF WATT UNLESS OTHERWISE SPECIFIED.
K = 1000 OHMS
MEG = 1,000,000 OHMS
ALL CAPACITORS ARE IN MICROMICROFARADS UNLESS OTHERWISE SHOWN
MFD = MICROFARADS

Elementary Diagram

30-54 MC RECEIVER
MODEL 4ER24B2

(DD-7669146, Rev. 2)

DESCRIPTION AND MAINTENANCE INSTRUCTIONS FOR 6/12/24-VOLT, MOBILE VIBRATOR POWER SUPPLY MEDIUM-POWER MODEL 4EP2G1

General Electric Mobile Vibrator Power Supply Model 4EP2G1 is a Progress Line Unit designed for use with the medium-power transmitter and receiver for operation from 6-volt, 12-volt or 24-volt battery systems. Input voltage conversion is accomplished through the use of a special power cable, the circuitry of which is controlled by correctly positioning the cover portion of the Fuse Box Assembly. Once a fleet of vehicles, having mixed 6, 12 and 24 volt battery systems, has been equipped with cables and a Fuse Box Assembly, the mobile transmitter-receiver, using Power Supply Model 4EP2G1 can be plugged into any of the vehicles without regard to vehicles input voltage.

All connections to transmitter, receiver and control unit are made through plug and cable connections to the power supply. This permits rapid replacement of the power supply, the transmitter or the receiver, using only a screw driver to make the change. Jacks are provided for metering the transmitter and receiver B-plus voltages and the input voltage. Metering may be done with a 20,000 ohm-per-volt voltmeter having a 0 to 3-volt scale. No voltages are exposed above the power supply chassis. Components and wiring points are fully accessible for servicing.

MAINTENANCE

To prevent undue interruption of the proper operation of the equipment, regular preventive maintenance procedures should be followed. This preventive maintenance should include the following:

1. A mechanical inspection of the unit for loose, broken or damaged components.

2. An inspection of the power and control cable connections.

3. Preventive maintenance on the battery, generator and voltage regulator on the vehicle.

4. Measurement of the transmitter B-plus and receiver B-plus voltages at the "HB+" jack, J507 (red-positive), and

at the "LB+" jack, J505 (red-positive), respectively. A 1-volt deflection on a 20,000 ohm-per-volt meter at the "HB+" jack (J507) indicates a transmitter PA B-plus voltage of 200 volts. A 1-volt deflection at the "LB+" jack (J505) indicates 100 volts of receiver B-plus on RECEIVE or 100 volts of transmitter oscillator B-plus on TRANSMIT. A voltage reading below 85% of the normal reading (see SERVICE OUTLINE) at either of these jacks indicates that the vibrator in use should be replaced.

5. A check of the input voltage at the "INP V" jack (J506). A 1-volt deflection at the jack indicates 10 volts of input voltage. A reading below 5.6 volts on 6-volt battery systems, 12.2 volts on 12-volt battery systems or 21.2 volts on 24 volt battery systems indicates low battery voltage or excessive voltage drop in the power cable connections.

6. A check of the relay contacts as described in the following section.

RELAY MAINTENANCE

The relays used in these units require little care. They should be inspected periodically, however, to assure maximum operating efficiency. If the contacts become pitted, they should be cleaned with a burnishing tool to smooth out any metallic deposits. When relay contacts carry little or no current, the contacts do not clean themselves and an insulating coating is apt to form. This coating may be removed by cleaning the contacts with a burnishing tool. Do not oil the relay bearings. When relays are in dusty locations, lubricated bearings will collect dust and grit and will wear more rapidly than non-lubricated bearings. Some of the relays used are of the multiple-contact type, and, in the unenergized position, the approximate contact spacing should be from .0625 to .125 inch. Most important, the spacing between contacts on any multiple-contact relay should be equal so that, when the relay is energized, the contact pressures will be equal. Check the back pressure of the antenna relay which should be at least 15 to 20 grams. If the back pressure is low, bend the support for the coil spring so as to stretch this spring. Low back pressure will shorten the life of contacts, due to excessive arcing, and may also cause noise in the receiver due to chatter of the antenna relay contacts under vibration.

CIRCUIT ANALYSIS

Power Supply Model 4EP2G1 supplies all operation voltage for the mobile transmitter and receiver. All connections to these units, both power and control, are made through a cable (W501) from the power supply.

VIBRATOR CIRCUITS

Power Supply Model 4EP2G1 contains two split reed, dual-interruptor type vibrators (E503 and E504), one of which, depending upon what source voltage is being utilized, is used to power the transmitter. Vibrator E503 is employed in the power circuits for 6 or 12 volt applications. The driver coil circuit of vibrator E503 is opened by relay contact K507-7R, for 24-volt applications, and vibrator E504 is then employed in the power circuit.

Only one half of each of the two primary windings of T512 (BK & R leads of top winding and BL & G leads of bottom winding) are used for 6 or 12 volt operation. The two portions of the primary windings are connected in parallel for 6-volt operation or in series for 12-volt operation, through the split reed of vibrator E503. The full winding of each primary of T512 are connected in series, for 24-volt operation, through the split reed of E504.

Under RECEIVE condition, only the BK-R, Y-G (black and red lead to yellow and green lead) section of the high-voltage secondary winding of T512 is used. The full winding is used on TRANSMIT. Filament and B-plus voltages for the transmitter and receiver are obtained as follows:

FILAMENT CIRCUITS

In 6 and 12 volt systems, filament voltage for the transmitter, receiver and power lite is supplied direct from the Fuse Box Assembly through the Power and Unit cables. In 24 volt systems, filament voltage (15 volts a-c) for the transmitter and receiver and power lite is supplied by the 0-0 secondary winding (orange lead to orange lead) of transformer T512, R559, C526B and L504 are used for filtering.

RECEIVER B-PLUS CIRCUIT

Receiver B-plus - The a-c voltage developed across the BKR-YG section of the HV secondary winding of T512 is rectified by the Y-BK-Y half of rectifier bridge CR503-CR511. The negative junction (BK) of the rectifier is grounded, and the receiver B-plus voltage is taken at center tap GBK of the HV winding and filtered by an RLC network composed of C502-A and B, L506, R501, C504-A and B and R524. Fuse F501 fuses the receiver B-plus.

RELAY CIRCUITS

Keying the transmitter, by closing the test switch (S501) or by pressing the button on the microphone (connected either at the control unit or at J509 on the power supply chassis), energizes relay K501, which then initiates the sequence outlined below: Note that K507 is used in 24 volt power supply only.

PILOT RELAY
K501

K501-4,5 close, energizing K101 (in transmitter) and K502 and lighting TRANSMIT lite (on Control Unit).

CHANGE-OVER RELAY
K507 (24-Volt Application Only)

Picked-up by throwing ON-OFF Switch to ON

K507-2L,3L close, completing path to hot side of pilot relay.

K507-5L,6L close, adds "A" voltage, filter capacitor C526A to input circuit, also completes Input Voltage metering circuit.

K507-2R,3R open, breaks driver coil circuit of 6/12 volt vibrator E503

K507-4R,5R close, applying 15 v a-c filament voltage to transmitter and receiver.

ANTENNA RELAY
K101

K101 energizes, switching antenna from receiver to transmitter.

CONTROL RELAY
K502

K502-1L,2L open, removing receiver B-plus.

K502-2L,3L close, applying transmitter oscillator B-plus.

K502-4R,5R close, applying transmitter multiplier B-plus.

K502-6R,7R close, applying transmitter PA B-plus.

K502-4L,5L open and 5L, 6L close to utilize full HV winding of T512 for transmitter B-plus voltages.

K502-2R,3R open and 1R,2R close, switching center tap of T512 HV winding from G-BK lead to R-Y lead.

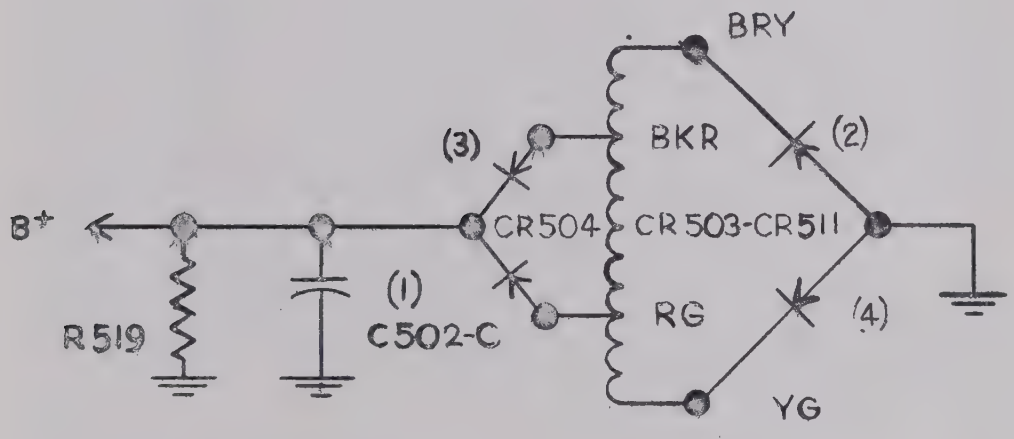
TRANSMIT LIGHT
1702

TRANSMIT lite on control unit lights.

TRANSMITTER B-PLUS AND BIAS CIRCUITS

Transmitter Oscillator B-Plus - With the power supply keyed, the a-c voltage developed across the full HV secondary winding of T512 is rectified by the Y-BK-Y half of rectifier bridge CR503-CR511. The negative junction (BK) of the rectifier is grounded and the transmitter B-plus voltage is taken at center tap RY of the HV winding and filtered by an LC-RC network composed of C502-A, L506, C502B, R501 and C504-A.

Transmitter Multiplier B-Plus - The B-plus voltage for the transmitter multiplier stages is obtained by using a full-wave tapped bridge rectifier circuit. A simplified diagram of the circuit is shown below:



HV WINDING OF T512

During one half of each a-c cycle, the voltage across the BRY-RG section of the HV winding is rectified by legs (1) and (2) of the bridge and, during the other half, the voltage across the BKR-YG section is rectified by legs (3) and (4). Filtering for the B-plus voltage is provided by C502-C. R519 is a bleeder resistor to discharge C502-C after the power is turned off.

Transmitter Power Amplifier B-Plus - The full-wave bridge rectifier composed of CR503 and CR511 rectifies the voltage present across the HV winding of T512. This voltage is filtered by capacitors C513 and C502-D and supplies B-plus voltage for the transmitter PA stage.

Transmitter Negative Bias - The a-c voltage across the low-voltage secondary winding (slate lead to slate and yellow lead) of transformer T512 is rectified by half-wave rectifier CR505 and filtered by C506 to supply negative bias for the transmitter 4th multiplier and power amplifier control grids. This negative bias is present as a protective measure to limit cathode current in the PA tube when the PA is untuned.

METERING CIRCUITS

Metering resistors R558 and R516 are used when measuring the voltage at the "INP V" jack (J506). A 1-volt deflection on a 20,000 ohm-per-volt voltmeter at this jack indicates 10 volts of input voltage. Due to the voltage drop in the power cable, the actual filament voltage and not the battery voltage will be measured at this jack.

The voltage read at the "LB+" jack (J505) must be multiplied by 100 to obtain the actual voltage across metering resistors R513 and R514. On RECEIVE, this will be the receiver B-plus voltage, but on TRANSMIT, the B-plus voltage for the oscillator stage of the transmitter will be read here. R513 and R514 also serve as bleeders to discharge filter capacitors C502-A and B and C504-A and B after the power supply is turned off.

The "HB+" jack (J507) has been provided for metering the B-plus voltage on the transmitter PA tube(s). The meter reading must be multiplied by 200 to obtain the actual B-plus voltage across metering resistors R510, R511, and R512. These resistors also serve as bleeders.

PARTS LIST
POWER SUPPLY, MODEL 4EP2G1

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
C502		Capacitor, fixed, electrolytic; polarized twist prong base, 4 section. Section A and B rated 30 mfd +100% -10%, 350 v d-c w; Section C and D rated 30 mfd +50% -10%, 450 v d-c w.	Section A & B, Rec.B+ filter; Section C, Trans.Mult. B+ filter; Section D, trans. Final B+ filter.
C504		Capacitor, fixed, electrolytic; polarized twist prong base, 2 Section. Section A rated 50 mfd +100% -10%, 350 v d-c w; Section B rated 10 mfd +100% -10%, 250 v d-c w.	Rec. B+ filter.
C505		Capacitor, fixed, ceramic dielectric; insulated miniature Hi-K disk, 0.02 mfd +60% -40% at 25°C, 250 v d-c w.	Vib. coil filter.
C506		Capacitor, fixed, electrolytic; tubular, 25 mfd +250% -10%, 50 v d-c w.	Bias filter.
C513		Capacitor, fixed, electrolytic; tubular, 15 mfd +50% -10%, 450 v d-c w.	Trans. B+ filter.
C516		Same as C505.	Hash filter.
C517		Same as C505.	Hash filter.
C518		Same as C505.	Filament Filter.
C520		Same as C505.	Hash filter.
C521		Same as C505.	Hash filter.
C523		Same as C505.	Primary Hash filter.
C526		Capacitor, fixed, electrolytic; non-polarized twist prong base, 3 section. Section A rated 75 mfd +250% -10%, 50 v d-c w; Section B rated 50 mfd +250% -10%, 50 v d-c w; Section C rated 50 mfd +250% -10%, 50 v d-c w.	Section A, hash filter; Section B, filament filter; Section C, filament filter.
C528		Capacitor, fixed, paper dielectric; oil filled, metal case, 0.008 mfd ± 20%, 1600 v d-c w.	Secondary Buffer.
C532 and C533		Capacitor, fixed, paper dielectric; molded plastic, 0.1 mmf ± 20%, 200 v d-c w.	Primary Buffer.
C536 thru C539		Same as C505.	Primary Buffers.
CR503		Rectifier, metallic, selenium; 24 cells in stack, forward current 120 ma, peak inverse 760/38 v, connected for doubler.	Rectifier.
CR504		Rectifier, metallic, selenium; 24 cells in stack, forward current 120 ma, peak inverse 380 v entire stack, connected for center tap.	Rectifier.
CR505		Rectifier, metallic, selenium; 1 cell, forward current 150 ma, peak inverse 64 v.	Rectifier bias.
CR511		Same as CR503.	Rectifier.
E503		Vibrator, non-synchronous; dual interrupter-split reed, operating voltage 6.0 v, input voltage range 4-8 v, reed freq. 100 ± 7 cps, pri interrupter. Capacity 48 v-amp, max current 8 amp, 1.3 w driving power.	Vibrator.
E504		Same as E503.	Vibrator.
F501		Fuse, cartridge; 1/8 amp at 250 v, type 3AG, quick to med blowing.	Rec. B+ fuse.
J502		Connector, receptacle, electrical; 21 male contacts. Part of W501.	Control connector.
J503		Connector, plug, electrical; molded connector with 11 female contacts, color red. Part of W501.	Transmitter connector.
J504		Same as J503, except color green.	Rec. connector.
J505		Jack, tip; test point jack, phenolic or urea. Red.	Rec. B+ metering.
J506		Jack, tip; test point jack, phenolic or urea. Lt. Blue.	Input metering.

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
J507		Same as J505.	Trans. B+ metering.
J508		Jack, tip; test point jack, phenolic or urea. Black.	Gnd. for metering.
J509		Connector, receptacle, electrical; 4 female Contacts.	Microphone receptacle.
J517		Connector, receptacle, electrical; 10 pin male Jones Type. Rated voltage 1100 V RMS, current capacity 15 amps.	Power input jack.
K501		Relay; coil operating range 4.9 to 6.9 v d-c, resistance 50 ohms ± 10%, at 25°C, spdt contacts.	Pilot.
K502		Relay; resistance 28 ohms ± 10% at 25°C, 7.2 v d-c operating max, pick up 4.5 v d-c or less, single 2 form A, 3 form C contacts.	Control.
K507		Relay; resistance 28 ohms ± 10% at 25°C, 7.2 v d-c or less operating, pick up 4.5 v d-c or less, single 1 form A, 3 form C contacts.	Control.
L501		Reactor; inductance 120 uh ± 10% at 1000 cps, d-c resistance 0.064 ohm max.	Filament choke.
L502		Coil, radio frequency; inductance 7.0 uh, current 1000 ma, frequency range 35-110 mc, red.	Vib. coil choke.
L504		Same as L501	Filament choke.
L505		Same as L502.	Vib. coil choke.
L506		Reactor; inductance 1.5 h at 0.085 amps d-c, d-c resistance 150 ohms max peak a-c ripple 10 v RMS at 60 cycles, d-c operating at 200 volts.	B+ choke.
R501		Resistor, fixed, composition; 47 ohms ± 10%, 2 w.	Rec. B+ filter and Trans. Osc. B+ filter.
R507		Resistor, fixed, wirewound; 7.5 ohms ± 10%, 5 w. Omit wire leads.	Dropping resistor 12 to 6 v for control circuits.
R509		Resistor, fixed, composition; 220 ohms ± 10%, 1 w.	Surge limiting (bias supply).
R510		Resistor, fixed, composition; 0.15 megohms ± 5%, 1/2 w.	Trans. B+ metering.
R511		Same as R510.	Trans. B+ metering.
R512		Resistor, fixed, composition; 1500 ohms ± 5%, 1/2 w.	Trans. B+ metering.
R513		Same as R510.	Rec. B+ metering.
R514		Same as R512.	Rec. B+ metering.
R516		Resistor, fixed, composition; 300 ohms ± 5%, 1/2 w.	Metering Resistor.
R518		Resistor, fixed, composition; 22,000 ohms ± 10%, 1 w.	Bias bleeder.
R519		Resistor, fixed, composition; 0.27 megohms ± 10%, 1/2 w.	Trans. multiplier B+ bleeder.
R530		Resistor, fixed, composition; 0.10 megohms ± 10%, 1/2 w.	Mike loading.
R542		Same as R501.	Rec. B+ Surge Limiting.
R547		Resistor, fixed, composition; 330 ohms ± 10%, 2 w.	Vibrator arc suppression.
R548		Same as R547.	Vibrator arc suppression.
R549		Same as R547.	Vibrator arc suppression.
R550		Same as R547.	Vibrator arc suppression.

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R556		Resistor, fixed, wirewound; 75 ohms ± 10%, 5 w. Omit wire leads.	Vibrator coil dropping.
R558		Resistor, fixed, composition; 2700 ohms ± 5%, 1/2 w.	Metering resistor.
R559		Resistor, fixed, composition; 150 ohms ± 10%, 2 w.	Filament ripple.
R560		Same as R559.	Current filter.
R561		Resistor, fixed, wirewound; 80 ohms ± 5%, 10 w, with pigtail leads.	Dropping resistor from 24 to 6 v for change over relay.
R562		Resistor, fixed, wirewound; 16 ohms ± 5%, 10 w, with pigtail leads.	Dropping resistor from 24 to 12 v for control circuits.
S501		Switch, push; red button, 1/2 amp at 115 v a-c, sp N.O. momentary contacts.	Transmit test switch.
T512		Transformer, power, vibrator; exciting current 16 v, 60 cycle a-c applied to pri on red and yellow leads of 0.125 amps ± 20%.	Vibrator power transformer.
W501		Cable Assembly, special purpose, electrical; includes molded connectors with 11 female contacts and connector with 21 male contacts.	Control and power.
XE503		Socket, vibrator; 7 prong laminated type, except location of control holes reversed from those in standard contacts.	Vibrator socket.
XE504		Same as XE503.	Vibrator socket.
XF501		Fuse holder, cartridge type.	Rec. B+ fuse holder.

STOCK NUMBER IDENTIFICATION
POWER SUPPLY MODEL 4EP2G1

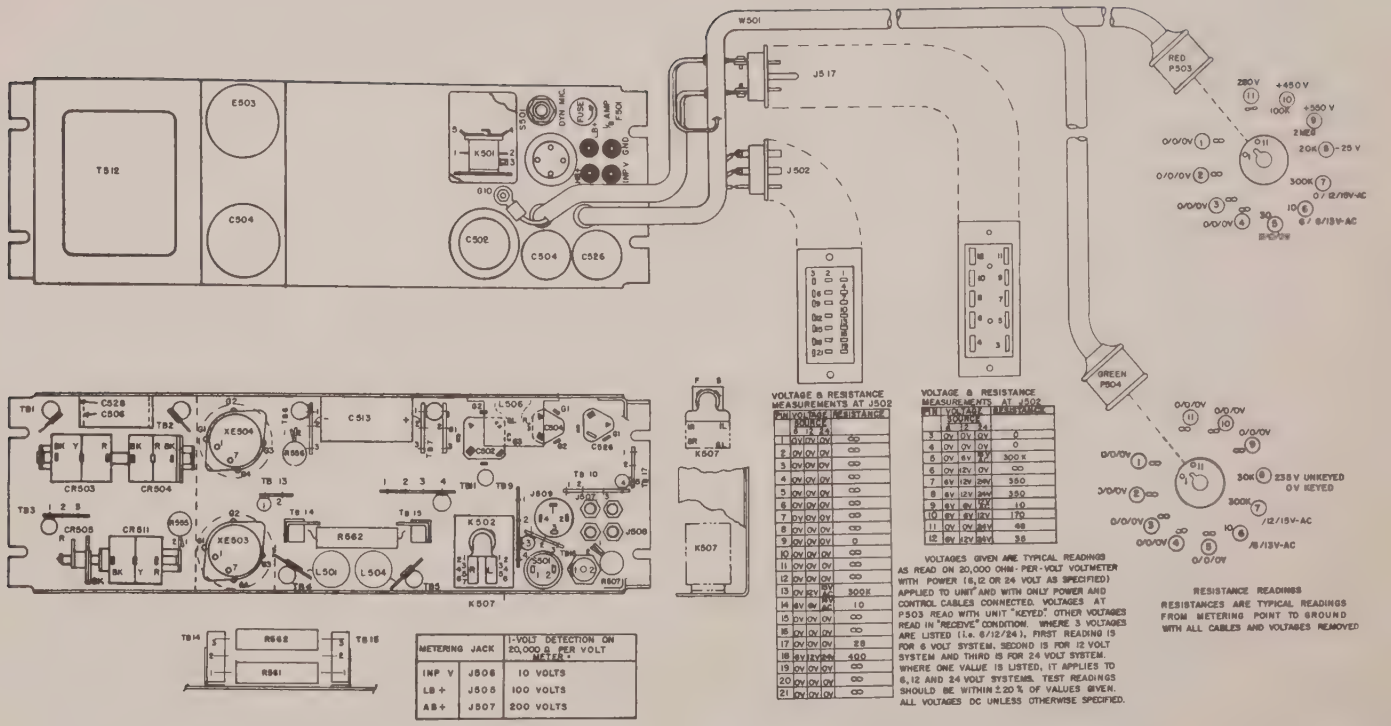
Ref. Symbol	General Electric Part Number	Manufacturer's Part Number		Stock Number
C 502	P-7772415-P46	MAL Type FP	**	N16-C023070-5911
C 504	P-7772415-P24	MAL Type FP	**	N16-C021584-5019
C 505	B-7487478-P3	CN Cat. DDM-203		N16-C019143-2451
C 506	C-7774786-P8	MAL Cat. #TC-36	**	N16-C019783-8801
C 513	C-7774786-P42	MAL Cat. #TC-74		For Replacement use SNSN N16-C019668-7001
C 526	P-7774297-P2	MAL	*	N16-C022780-1003
C 528	M-7476463-P4	MAL Cat. #OT-372	**	N16-C039617-1800
C 532	P-7481651-P13	SPR Cat. #67P10402		N16-C045803-3731
CR 503	A-7144141-P2	GE Cat. #6RS21PD12BA1		N17-R051107-6131
CR 504	A-7144141-P1	GE Cat. #6RS21CP12BA1		N17-R051304-1116
CR 505	A-7140806-P1	GE Cat. #6RS21PH1AT1		N17-R050942-6133
E 503	A-7141584-P2	OAK Type V-6854		N17-V050578-9948
F 501	K-1R16-P12	(LTF Cat. #312-125 (BUS Cat. #AGC-1/8		N17-F016302-0030
J 502		JNS Cat. #P-321SB		N17-C073618-6534
J 503		CMS Cat. #1601-F11		N17-C071288-2399
J 505	A-7143966-P2	APDP Type 110BSC-red		N17-C073108-1901
J 506	A-7143966-P6	APDP Type 110BCS-lt.blue		N17-J039985-4938
J 508	A-7143966-P1	APDP Type 110BCS-black		N17-C073108-5347
J 509	K-7117934-P2	AMP Type 91-PC4F		N17-C073184-9460
J 517	A-7147228-P1	JNS Cat. #P-410-SB		N17-C073569-9228
K 501	K-7127542-P2	PRL Cat. #1001		N17-R064847-2183
K 502	C-7774180-P1	PBR Cat. #MJ-1194		N17-R065150-5944
K 507	C-7774180-P6	PBR Cat. #MJ-1195		N17-R065230-5946
L 501	A-7143944-P1	FST	*	N16-C073974-6234
L 502	P-7772834-P4	OM Cat. #Z-50		N16-C073045-9468
L 506	B-7489398-P1	SNC	*	N16-R028971-6227
R 501	C-3R79-P470K	AB Type HB	**	N16-R049428-0498
R 507	B-7487415-P108	MOD Type FR8-5	**	N16-R068307-8612
R 509	C-3R78-P221K	AB Type GB	**	N16-R049662-0238
R 510	C-3R77-P154J	IRC Type BTS	**	N16-R050677-0380
R 512	C-3R77-P152J	IRC Type BTS	**	N16-R049966-0433
R 516	C-3R77-P301J	IRC Type BTS		N16-R049696-0438
R 518	C-3R78-P223K	AB Type GB	**	N16-R050373-0238
R 519	C-3R77-P274K	IRC Type BTS	**	N16-R050741-0818
R 530	C-3R77-P104K	IRC Type BTS	**	N16-R050633-0785
R 547	C-3R79-P331K	AB Type HB	**	N16-R049707-0511
R 556	B-7487415-P117	MOD Type FR8-5	*	For Replacement use SNSN N16-R070481-5831
R 558	C-3R77-P272J	IRC Type BTS	**	N16-R050039-0721
R 559	C-3R79-P151K	AB Type HB	**	N16-R049626-0503
R 561	M-7478740-P20	SPR Type 10KT	**	N16-R065624-5843
R 562	M-7478740-P13	SPR Type 10KT	**	N16-R065383-8834

STOCK NUMBER IDENTIFICATION
POWER SUPPLY MODEL 4EP2G1

Ref. Symbol	General Electric Part Number	Manufacturer's Part Number		Stock Number
S 501	M-7481654-P1	GRAY Cat. #4001		N17-S056408-5309
T 512	B-7489356-P1	GE		N17-T078528-5419
W 501	B-7488632-P1	GE		N17-C048546-1012
XE 503	A-7141618-P1	CIN Cat. #2167		N16-S062728-5953
XF 501	K-7115179-P1	BUS Type HKP	**	N17-F074267-5075

* This part has been manufactured to meet General Electric Purchase Specifications. When ordering from the manufacturer, order by General Electric Part Number.

** When ordering this part from the manufacturer, specify type and information included under name and description.



VOLTAGE & RESISTANCE MEASUREMENTS AT J502

PIN	VOLTAGE SOURCE			RESISTANCE
	6	12	24	
1	0V	0V	0V	∞
2	0V	0V	0V	∞
3	0V	0V	0V	∞
4	0V	0V	0V	∞
5	0V	0V	0V	∞
6	0V	0V	0V	∞
7	0V	0V	0V	∞
8	0V	0V	0V	∞
9	0V	0V	0V	0
10	0V	0V	0V	∞
11	0V	0V	0V	∞
12	0V	0V	0V	∞
13	0V	12V	24V	300K
14	6V	6V	6V AC	10
15	0V	0V	0V	∞
16	0V	0V	0V	∞
17	0V	0V	0V	28
18	6V	12V	24V	400
19	0V	0V	0V	∞
20	0V	0V	0V	∞
21	0V	0V	0V	∞

VOLTAGE & RESISTANCE MEASUREMENTS AT J502

PIN	VOLTAGE SOURCE			RESISTANCE
	6	12	24	
3	0V	0V	0V	0
4	0V	0V	0V	0
6	0V	6V	12V	300 K
6	0V	12V	0V	∞
7	6V	12V	24V	350
8	6V	12V	24V	350
9	6V	6V	12V	10
10	6V	6V	12V	170
11	0V	0V	24V	48
12	6V	12V	24V	28

VOLTAGES GIVEN ARE TYPICAL READINGS AS READ ON 20,000 OHM-PER-VOLT VOLTMETER WITH POWER (6,12 OR 24 VOLT AS SPECIFIED) APPLIED TO UNIT AND WITH ONLY POWER AND CONTROL CABLES CONNECTED. VOLTAGES AT P503 READ WITH UNIT "KEYED". OTHER VOLTAGES READ IN "RECEIVE" CONDITION. WHERE 3 VOLTAGES ARE LISTED (i.e. 6/12/24), FIRST READING IS FOR 6 VOLT SYSTEM, SECOND IS FOR 12 VOLT SYSTEM AND THIRD IS FOR 24 VOLT SYSTEM. WHERE ONE VALUE IS LISTED, IT APPLIES TO 6,12 AND 24 VOLT SYSTEMS. TEST READINGS SHOULD BE WITHIN ±20% OF VALUES GIVEN. ALL VOLTAGES DC UNLESS OTHERWISE SPECIFIED.

RESISTANCE READINGS

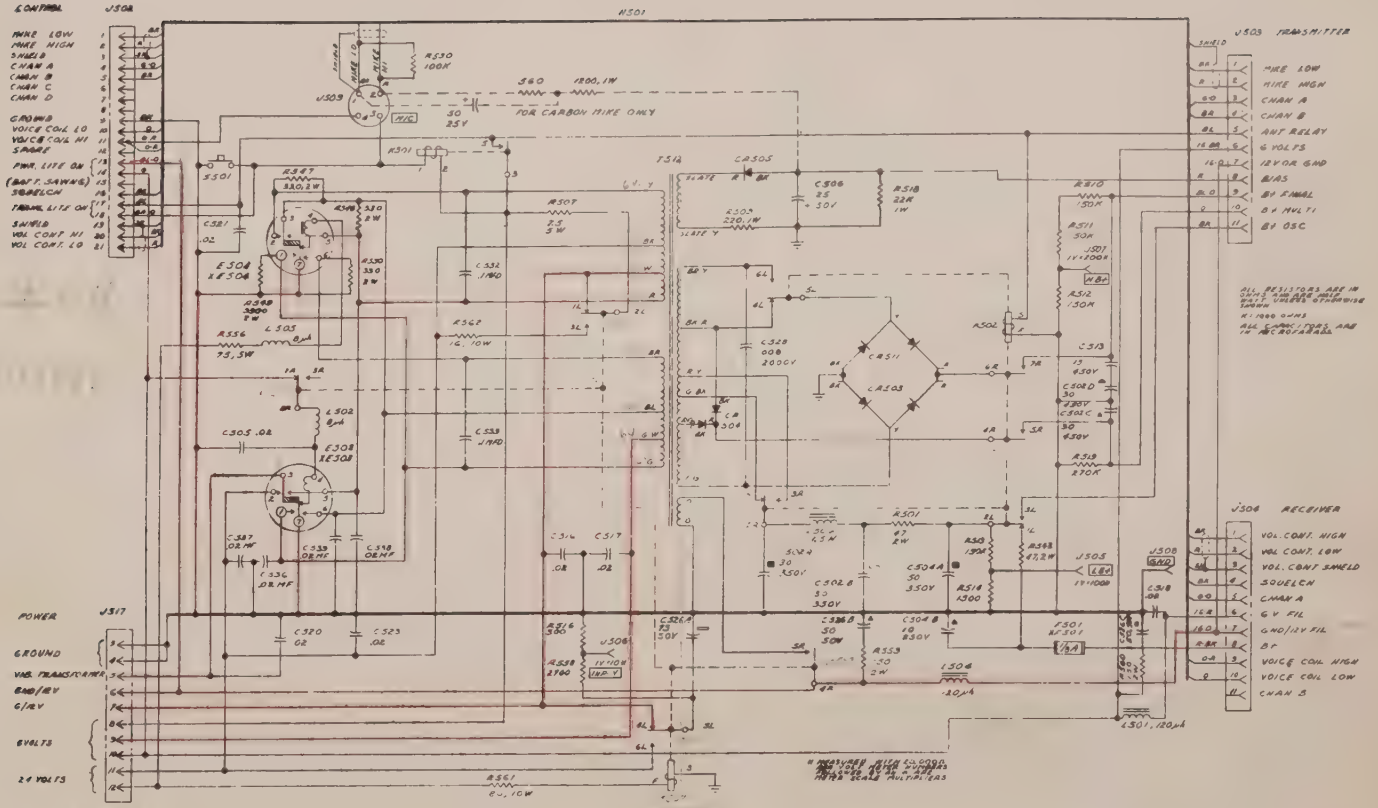
RESISTANCES ARE TYPICAL READINGS FROM METERING POINT TO GROUND WITH ALL CABLES AND VOLTAGES REMOVED

METERING JACK	1-VOLT DETECTION ON 20,000 Ω PER VOLT METER
INP V J506	10 VOLTS
LB + J505	100 VOLTS
AB + J507	200 VOLTS

Service Outline

6/12/24-VOLT MOBILE
POWER SUPPLY MODEL 4EP2G1

(D-7669212, Rev. O)



Elementary Diagram

6/12/24-VOLT MOBILE
POWER SUPPLY MODEL 4EP2G1

(D-7669303, Rev. 2)

PARTS LIST
MOBILE CONTROL UNIT MODEL 4EC27A1

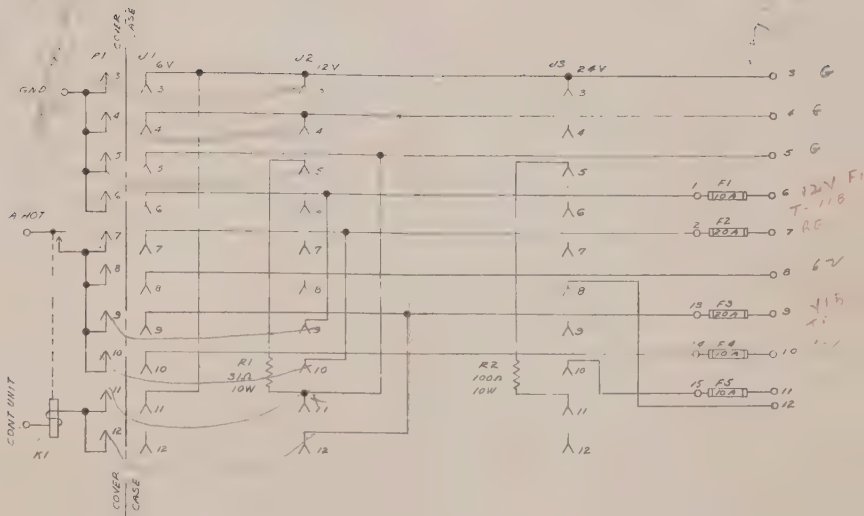
REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
F701		Fuse, cartridge; 1 amp, 250 v, Type 3AG, quick to med blowing.	Control line fuse.
H701		Knob: Set Screw.	
H702		Same as H701.	
I701		Light, Indicator; part of XI701. 7.5 v, 1 cp, miniature bayonet base.	Power-On indicator.
I702		Same as I701. Part of XI702.	Transmit indicator.
J701		Connector, receptacle, electrical; 4 female contacts.	Microphone jack.
J702		Socket, electron tube; connector pin receptacle, 8 female contacts.	Control cable receptacle.
J703		Same as J702.	Control cable receptacle.
J704		Same as J702.	Control cable receptacle.
R701		Resistor, variable, composition; 250,000 ohms ± 20%, 2 w. mod log taper.	Volume control.
R702		Resistors, variable, composition; 15,000 ohms ± 20%, 2 w, linear taper.	Squelch control.
R703		Resistors, fixed, composition; 2200 ohms ± 10%, 1/2 w.	Earpiece dropping resistor.
S701		Switch, toggle; spst, 3 amp at 250 v.	On-Off switch.
XF701		Fuse Holder; cartridge type.	Inline type fuse holder.
XI701		Light, indicator; includes I701, green lens.	Power-on indicator.
XI702		Light, indicator; includes I702, red lens.	Transmitter indicator.

STOCK NUMBER IDENTIFICATION
MOBILE CONTROL UNIT MODEL 4EC27A1

Ref. Symbol	General Electric Part Number	Manufacturer's Part Number		Stock Number
F 701	K-1R16-P3	LTF Cat. #312001		G5920-280-4465
H 701	B-7487773-P5	BUS Cat. #AGC-1		N16-K702781-0251
I 701		GE Cat. #51		G6240-011-5273
J 701	K-7117934-P2	AMP Type 91-PC4F		N17-CO73184-9460
J 702		CIN Cat. #11961		N16-SO63452-2801
R 701	M-2R74-P22	AB Type J	**	N16-RO88082-5293
R 702	M-2R73-P15	AB Type J	**	N16-RO87712-3210
R 703	C-3R77-P222K	IRC Type BTS	**	For Replacement use SNSN N16-RO50011-0438
S 701	M-7478623-P1	AHH Type 20994-WJB		N17-SO71338-5931
XF 701	K-7124109-P2	BUS Type HDJD	**	N17-FO74265-1184
XI 701	A-7138347-P12	DLC Type 755-62 special	**	N17-LO76765-2786
XI 702	A-7138347-P11	DLC Type 755-62 special	**	N17-LO76767-6214

* This part has been manufactured to meet General Electric Purchase Specifications. When ordering from the manufacturer, order by General Electric Part Number.

** When ordering this part from the manufacturer, specify type and information included under name and description.



Connection Diagram

FUSE BOX ASSEMBLY
PL-7776234-G1

(B-7491030, Rev. 1)

PARTS LIST
MOBILE FUSE BOX ASSEMBLY PL7776234-G1

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
A1		Fuse Box; Base assembly.	
A2		Fuse Box; Cover assembly, includes 2 - #4 AWG Wires, 4 ft. long.	
H1		Fuse Box; Cover assembly, handle.	
TB1		Terminal Board; mounts in fuse box base assembly, power cable termination.	
F1		Fuse, cartridge; lug mt. type, quick to med blowing, 10 amp at 250 V.	6 & 12 V Filament Fuse.
F2		Fuse, cartridge; lug mt. type, quick to med blowing, 20 amp at 250 V.	6 & 12 V Vibrator Fuse.
F3		Same as F2.	6 & 12 V Vibrator Fuse.
F4		Same as F1.	6 V Filament Fuse.
F5		Same as F1.	24 V Power Fuse.
J1		Connector, receptacle, electrical; 10 pin male.	6 V Input power switching connector.
J2		Same as J1.	12 V Input Power switching connector.
J3		Same as J1.	24 V Input Power Switching Connector.
K1		Relay; resistance 36 ohms ± 8% at 25°C, pick up 4.5 V or less at 25°C, drop out 1.0 V or more at 25°C, 7.5 V max continuous operate, control pressure with 6 V on coil, 100 gms min. 10 female contacts.	Power on relay.
P1		Connector, plug, electrical; 10 female contacts.	Input Power Plug.
R1		Resistor, fixed, wirewound; 31 ohms ± 5%, 10 w.	12 volt Power Relay Coil Dropping.
R2		Resistor, fixed, wirewound; 100 ohms ± 5%, 10 w.	24 volt power Relay Coil Dropping.

STOCK NUMBER IDENTIFICATION
MOBILE FUSE BOX ASSEMBLY PL-7776234-G1

Ref. Symbol	General Electric Part Number	Manufacturer's Part Number	Stock Number
A 1	PL-7491028-G1	GE	Shop Manufacture
A 2	B-7491029-P1	GE	Shop Manufacture
H 1	A-7141041-P1	GE	Low failure item. If required, requisition from ESO referencing Navy Ships 900,180A
TB 1	B-7491027-P1	GE	Shop Manufacture
F 1	A-7142444-P9	BUS Type HBO-10 **	N17-F014272-0940
F 2	A-7142444-P1	BUS Type HBO-20 **	N17-F014272-0945
J 1	B-7477483-P2	JNS Cat. #P-410-AB	N17-C071567-4103
K 1	B-7486515-P1	EWA Cat. #60-108013-3	N17-R064918-9103
P 1	A-7150145-P2	JNS Cat. #S-410FHE	N17-C070121-5934
R 1	M-2R12-P16	WAL Cat. #10F31	N16-R068330-4510
R 2	M-2R12-P21	WAL Cat. #10F100	N16-R065679-8508

* This part has been manufactured to meet General Electric Purchase Specifications. When ordering from the manufacturer, order by General Electric Part Number.

** When ordering this part from the manufacturer, specify type and information included under name and description.

MW13W MOBILE COMBINATION ACCESSORIES

ACCESSORY	DESCRIPTION	G.E.DWG.NO.	STOCK NO.	VENDOR
A901	Cabinet, Electrical Equipment; Trans-Rec.- Power Supply Case. Mobile unit case consisting of base section PL7774228G2, cover section PL7774390G3, rack frame PL7486492G1, front panel PL7488836G7 (including pull-out handle A7141041-P1, locking handle A7145342-P1, lock rods A7146427-P1 & A7146427-P5, & cable terminated on one end by phono-plug and on other end by type 83RGUHF receptacle).	C7774394G9	Low failure item if required requisition from ESO referencing Nav Ships 900,180A	General Electric
MK902	Microphone, Magnetic; hand type; controlled reluctance, high impedance output at least 55 db below 1V per microbar per 1KC, includes 3 conductor with one under shield retractable tinsel cord. Shure Bros. Cable Spec #15A407A. 13" retracted length, and one 4 pin amphenol plug Cat. #MC4M. Cable with two connectors assembled, Shure Bros. Spec. #90H262.	4EM10A1	N17-M047994-3251	Shure Bros.
LS901	Loud Speaker, Permanent Magnet; dash mount type 4 inch 4W, voice coil impedance 3.2 ohms ± 10%. GE Type S400C22 (M7485089-P1). Includes 10 feet of GE Type POSJ bona rip cord #18-2 conductor.	4EZ1A4	M17-L091270-1085	General Electric
E901	Antenna	4EY5A2	Assemble from Component Parts	Antenna Specialists
MP901	Ball Joint and Mounting bracket	PL7472880-G5	Low failure item-if required requisition from ESO referencing Nav Ships 900,180A	
MP902	Base Assembly; Rod; Quarter wave (must be cut to frequency)	PL7483915-G2	N16-A052272-2054	
MP903	Spring Adaptor; Steel whip spring.	PL7476632-G3	N16-A070501-1185	
P901	Connector Plug: Amp. #83-1SP	M2R22-P1	For Replacement use N17-C071414-2800	

N129P2510C13 MW13W MOBILE COMBINATION ACCESSORIES (CONTINUED)

ACCESSORY	DESCRIPTION	G.E.DWG.NO.	STOCK NO.	VENDOR
W901	Control Cable; 17 feet of 12 conductor (2-#20RWG and 10 #22AWG) cable A7139880P2 terminated at one end in a 21 pin P502 (HB Jones S32; -FHE 9/16 dia. flared cable hole) and at other end by 12 tapered (plug M7483559P29) end pins with marker, R7141843.	B7487964-G2	N17-CO48660-8274	General Electric
W904	RF Cable; Receiver to transmitter. Cable assembly made up of 10 inches of RG-58/U terminated at either end in pin plug connector 7104941-P6 (one molded in to angle plug).	PL7488600-P24	N16-CO11775-9848	Component Mfg. Service
W903	Antenna Cable; Cable assembly, made up of 5 feet of RG-8/U terminated at one end in two piece straight UHF connector plug M2R22-P1 (amphenol Cat. #83-1SP) and at other end in terminal lug V417591 and cable lug (shield ground) K7110208-P1.	PL7474980-P6	Shop Manufacture	General Electric
Power Cable W907	C18 feet of 10 conductor cable (one #6 AWG P501 terminated with terminal lug K7100622-P1, three #8 AWG terminated in terminal lug K7100621P3, two #12 AWG terminated in terminal lug K7100474-P4 and four #16 AWG terminated in terminal lug K7100473-P4) terminated in 10 pin plug A7150145-P1 (HB Jones Co.Cat. #S-410-FHE).	PL7489268-G1	Shop Manufacture	General Electric
Suppressor Kit Z901	Consists of 1 - 10,000 ohm cable type suppressor (similar to Continental Carbon Co. Cable type suppressor C11) and 2 - 0.5 MF, ± 20% Metal clad fixed paper capacitor including mounting lug and spade lug terminated lead (similar to Cornell Dubilier type 1C-2P5C wax filled hermetically sealed capacitor).	PL7131678-G3	N17-SO51101-1001	General Electric

NW13W MOBILE COMBINATION ACCESSORIES (CONTINUED)

ACCESSORY	DESCRIPTION	G.E.DWG.NO.	STOCK NO.	VENDOR
Mtg. Hardware H905	Consists of 6 - 1/4" x 5/8" screws (for mounting trans-rec), 10 - #8 X 3/4" screws (for clamp, control unit, and speaker), 2 - #8 x 1-1/2" screws (for speaker mount), 5 - clamps A7147193 (for clamping cable to running surface), 1 wire cleat (for main control lead).	A7142621-P2	For reference only	General Electric
H903	Alignment Tool; Clear Plastic, 6" long, 0.25 inch diameter.	A7144890-P1	Procured on demand by nearest Naval Shore Supply Activity	General Component Mfg.
Tools	Consists of 1 - special purpose wrench for 1/2" nut A7134714-P1, 1 Allen wrench for #10 set screw or #5-6 socket head cap screw K7897119-P5), and 1 - Allen wrench for 5/8" set screw or 3/8" - 7/16" socket head cap screw (K7897119-P17).	A7139389-G1	For reference only	General Electric

GENERAL INFORMATION

The following information has been included to assist the customer and serviceman in the use of this instruction book.

NAMEPLATE INFORMATION

General Electric Radio Communication Equipment is identified by a nameplate attached to the case or chassis of the unit. Typical nameplates currently in use are shown in Fig. 1 and Fig. 2.

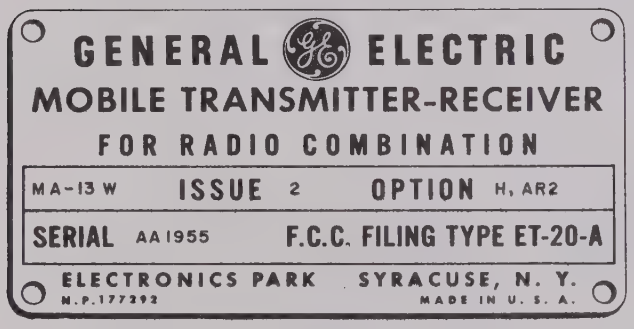


Fig. 1 Mobile Transmitter-Receiver Nameplate

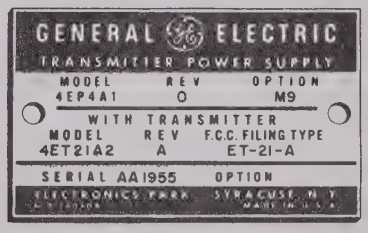


Fig. 2 Station Transmitter Nameplate

"TYPE" numbers (such as Transmitter Type ET-20-A in Fig. 1) describe general classes of equipment and are used only for broad identification and, in the case of transmitters, for FCC filing.

"MODEL" numbers (such as Power Supply Model 4EP4A1 and Transmitter Model 4ET21A2 in Fig. 2) describe units in more detail than their type numbers and are essential for proper identification.

The "REV" letter indicates what production changes have been made on the unit. When the unit has a nameplate, the revision letter is stamped on the nameplate. Otherwise, the revision letter follows the model number stamped on the chassis of the unit.

The "OPTION" pad on the nameplate is stamped with one or more letters indicating the optional modifications that have been added to the equipment. The "M9" stamped in the "OPTION" pad in the nameplate in Fig. 2, for example, indicates that the transmitter power supply has been modified for the use of a carbon microphone.

When writing for replacement parts, service information, etc. for a particular unit, the customer should give the model number, revision letter and option letters of the unit, as indicated in the following example:

Transmitter: Model 4ET21A2, Rev. A, Option none

The "COMBINATION" number (such as "MA-13-W" in Fig. 1) describes the complete mobile or station combination. The "ISSUE" number indicates what models of equipment are in the combination. A new issue number is used each time one or more of the units in the combination changes model number. The serial numbers are provided for the convenience of the customer in identifying his transmitters.

PRODUCTION CHANGES

From time to time, changes are made to the production equipment described in this book, either to improve performance or to simplify circuits. Any change made on a production unit will be assigned a Revision Letter, which will be stamped after the model number of the unit on the nameplate or on the chassis. A Revision Letter system is used as a means of identifying equipment and recording the changes made. Any given revision will always include all previous revisions.

A Production Change Sheet is located at the front of the section of the instruction book covering a unit that has been revised. This sheet lists the changes in the instruction book necessitated by each revision made on the unit. The Production Change Sheets should be used for checking and/or correcting instructional material to correspond with the revision/s of the equipment being serviced.

REPLACEMENT PARTS

A list of all principal replacement parts for each unit of this equipment is included in the section of the book

covering the unit. The symbol numbers used are the same as those appearing on the elementary diagram and other drawings. Replacement parts may be obtained from authorized G-E Service Stations or ordered through any G-E Communications Equipment District Sales Office (see list of sales offices on last page). When ordering a part, please include the symbol number, description, and drawing number of the part and the model number and revision letter stamped on the unit.

SAFETY NOTICE

Since the use of high voltages is necessary for the successful operation of the radio equipment described in this instruction book, certain reasonable precautions must be carefully observed by the operating personnel during the installation, operation and maintenance of the equipment.

Although every practicable safety measure has been incorporated in this equipment, the following rule must be strictly observed:

WARNING

Under no circumstances should any person be permitted to handle any portion of the equipment that is supplied with high voltage, or to connect any external apparatus to the units while the units are supplied with power. KEEP AWAY FROM LIVE CIRCUITS.

WARRANTY

The General Electric Company warrants to the original purchaser for use of Radio Communication Equipment sold under the General Electric trademark that it shall be of the kind and quality described in the applicable specifications published for the equipment and that it is free from defects in material or workmanship. No other warranty, except of title, shall be implied.

If any failure to comply with the specifications or if any defect in material or workmanship appears within one year from the original date of shipment by the General Electric Company (except as qualified below), the purchaser shall

notify the General Electric Company thereof immediately and the Company shall correct the defect by repairing the defective part or by supplying a replacement thereof on a no-charge basis to the purchaser. However, if the equipment is installed by the Company or if its installation is supervised under contract by the Company or its authorized service representatives, said warranty shall be one year from the date of the completion of the installation, provided that same is not unreasonably delayed by the purchaser. In no event, however, shall the warranty extend more than eighteen months from the original date of shipment by the General Electric Company.

In lieu of the foregoing, the warranty period for electronic tubes is the manufacturer's standard warranty period, which shall apply to any tubes incorporated in or supplied with the equipment. Certain components inherently subject to wear, such as vibrators, pilot lights, and fuses will be subject to limited warranty; vibrators are warranted for 30 days, and pilot lights and fuses are warranted to be operable on arrival only. The warranty period for equipment not manufactured by General Electric Company and bearing the name and/or trade-mark of another manufacturer, will be the manufacturer's standard warranty covering the equipment.

The performance of Equipment and the liability of the Company under this warranty provision is contingent upon a systematic program of routine maintenance by a qualified communications technician, who in addition holds a first or second-class radio telephone or telegraph operator's license in accordance with FCC regulations. The nature of electronic communication equipment is such that routine maintenance by a qualified technician is essential to reliable operation and minimized maintenance costs.

Defective parts should not be returned until authorized by the Company.

In no event shall any claim for consequential damages be made by either part.

The liability of the Company (except as to title) arising out of the supplying of said equipment, or its use, whether on warranties or otherwise, shall be limited to the correction of defects of aforesaid, and upon expiration of the warranty period all such liability shall terminate. The foregoing is in lieu of all other warranties express, implied or statutory, and the General Electric Company neither assumes

nor authorizes any person to assume for it any other obligation or liability in connection with said equipment.

The requirements of the Consolidated Freight Classifications are met by the Company in packing Radio Communications Equipment. Since shipment is F.O.B. factory, acceptance by carrier constitutes delivery by the company, and purchasers must file any claim for damage or loss in transit against the carrier. Any claim should cover concealed damage as well as visible damage. Upon request, the Company will supply purchasers with shipping papers necessary to support such claims.

INPUT POWER TO TRANSMITTERS

FCC rules and regulations for the land-mobile services state:

"The licensee of each station shall employ a suitable procedure to determine that the plate power input to the final radio frequency stage of each base station or fixed transmitter...does not exceed the maximum figure specified on the current station authorization."

The power input to the final RF stage of a transmitter can be calculated by the following formula:

$$\text{Power input} = \text{Plate voltage X plate current}, \quad (1)$$

where power input is in watts, plate voltage in volts, and plate current in amperes.

If the plate current cannot be measured directly, and the cathode current is used in the above formula, the value of power input will exceed the plate power input by the screen grid input plus the control grid input.

Should it be desirable to determine the plate current rather than the cathode current, it may be derived from the cathode current by means of the following formula:

$$I_p = I_c - I_{sg} - I_g, \quad (2)$$

where I_p is the plate current, I_c the cathode current, I_{sg} the screen grid current, and I_c the control grid current.

In most cases, the screen grid current (I_{sg}) cannot be metered conveniently. In such a case, it can be calculated

by the following formula:

$$I_{sg} = \frac{V_{rsg}}{R_{sg}} \qquad (3)$$

where V_{rsg} is the voltage across the screen resistor, and R_{sg} is the resistance of the screen resistor.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation, or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the nearest General Electric Company District Sales Office.

COMMUNICATIONS EQUIPMENT
DISTRICT SALES OFFICES

Requests for service information and orders for replacement parts not obtainable from a local radio dealer may be directed to the nearest office listed below or to the General Electric Company, Technical Products Department, New York Mills, Utica, New York.

ATLANTA	404 Henry Grady Office Bldg. 26 Cain Street	Alpine 5811
WELLESLEY, MASS.	471 Washington St.	5-6040
BUFFALO	Room 609 Sidway Bldg., 775 Main St.	Cleveland 2075
CHARLOTTE	Room 116 Builders Bldg., 314 W. Trade St.	Franklin 5-5244
CHICAGO	3118 West Devon Avenue	Briargate 4-5720
CINCINNATI	215 W. Third St.	Main 5022
CLEVELAND	710 Williamson Bldg. Euclid and Public Square	Superior 1-6822
COLUMBUS	Rm. 1018 Atlas Bldg., 8 E. Long St.	Capitol 1-7489
DALLAS	3200 Maple Avenue	Prospect 4296
DENVER	650 Seventeenth St.	Keystone 4-7171
DETROIT	16247 Wyoming Ave.	Diamond 1-1459
HOUSTON	Prudential Bldg., 1100 E. Holcomb Blvd.	Justin 0657
INDIANAPOLIS	110 North Illinois St.	Melrose 4-3426
JACKSONVILLE	1628 San Marco Blvd. Rm. 1A	Exbrook 7936
KANSAS CITY	106 West 14th Street	Victor 9745
LINCOLN	Room 618 Sharp Bldg.	21133
LOS ANGELES	Room 618, 3460 Wilshire Blvd.	Dunkirk 5-2391
MINNEAPOLIS	4029 Vernon Ave., South	Walnut 2300
MONTGOMERY	417 Bell Bldg.	4-7934
NASHVILLE	1805 Hayes Street	6-0832
NEW ORLEANS	236 Lee Circle Bldg.	Tulane 5871
NEW YORK	Rm. 1200, 271 North Ave.New Rochelle,N.Y.	NE-3-7012
PHILADELPHIA	1405 Locust St.	Penny- 5-9000 packer
PHOENIX	1102 North 22nd Ave.	Alpine 8-6721
PITTSBURGH	5907 Penn Ave.	Emerson 1-3379
PORTLAND	2727 N.W. 29th Avenue	Atwater 0281
ST. LOUIS	4227 Lindell Blvd.	Jefferson 5-8873
SALT LAKE CITY	200 S. Main Street	4-1892
SAN ANTONIO	335 New Moore Bldg.	Capitol 4-7151
SAN FRANCISCO	235 Montgomery Street	Douglas 2-3740
SEATTLE	220 Dawson Street	Seneca 8300
SYRACUSE	3001 James St.	73-6731
	Les Lee Bldg.	73-6831
OKLAHOMA CITY	3101 Classen Street	Jackson 4-7131
WASHINGTON	Room 900 Wyatt Bldg., 777- 14th St.,N.W.	Executive 3-3600

LIST OF MANUFACTURERS

ABBR AND CODE NO.	MANUFACTURER'S NAME AND ADDRESS
AB	Allen Bradley Co. 136 W. Greenfield Ave. Milwaukee 4, Wisconsin
AHH	Arrow Hart & Hegeman 100 Hawthorne Street Hartford 6, Conn.
AMP	American Phenolic Corp. 1830 S. 54th St. Chicago 50, Ill.
APDP	Alden Products 119 N. Main Street Brockton 64, Mass.
BUS	Bussman Mfg. Co. 2538 W. University St. St. Louis 7, Missouri
CLA	C. P. Clare Company 3101 W. Pratt Blvd. Chicago 45, Ill.
CIN	Cinch Mfg. Corp. 1026 S. Homan Ave. Chicago 24, Ill.
CLD	Cornell Dubulier Electric Corp. 1000 Hamilton Blvd. South Plainfield, N. J.
CMS	Components Mfg. Service 44 Ellis Ave. West Bridgeport, Conn.
CN	Centralab, Div. of Globe Union Inc. 932 E. Keefe Ave. Milwaukee 1, Wis.
CP	Columbus Process Co., Inc.
CPH	Chicago Telephone Supply Corp. 1142-1232 W. Beardsley Ave. Elkhart, Indiana

LIST OF MANUFACTURERS

ABBR AND CODE NO.	MANUFACTURER'S NAME AND ADDRESS
DLC	Dialight Corp. 60 Stewart Ave. Brooklyn 37, N. Y.
EBY	H. H. Eby Company 4571 Stenton Ave. Philadelphia, Pa.
EMC	Eitel-McCullough, Inc. (Eimac) San Bruno, Calif.
EMM	Electro Motive Mfg. Co. S. John & Park Sts. Willimantic, Conn.
ERC	Erie Resistor Corp. 641 W. 12th St. Erie, Penna.
EWA	Essex Wire Corp. Magnetic Winding Div. Freemansburg Rd. Easton, Penna.
FST	John E. Fast Co. 3115 N. Crawford Ave. Chicago 41, Ill.
GE	General Electric Co. Schenectady 5, N. Y.
GRAY	Grayhill Company 531 Hillgrove Ave. La Grange, Illinois
HTM	R. E. Hart Mfg. Co. P. O. Box 72 Ann Arbor, Mich.
IRC	International Resistance Co. 1101 Terminal Commerce Bldg. Philadelphia 8, Pa.
JFE	Jeffers Elect. Div. of Speer Carbon Co. Du Bois, Pa.
JNS	H. B. Jones 2640 W. George St. Chicago, Ill.

LIST OF MANUFACTURERS

ABBR AND CODE NO.	MANUFACTURER'S NAME AND ADDRESS
JON	E. F. Johnson Waseca, Minn.
KTC	Kenyon Transformer Co. 842 Barry St. New York, New York
LTF	Littelfuse, Inc. 1865 Miner St. Des Plaines, Ill.
MAL	P. R. Mallory & Co., Inc. 3670 Milwaukee Ave. Chicago, Ill.
MIC	Micamold Radio Corp. Flushing, Knickerbocker & Tyler Aves. Brooklyn 37, New York
MIRE	Milwaukee Resistor Co. 702 W. Virginia Ave. Milwaukee, Wisconsin
MOD	Model Engineering and Mfg. Co. Chicago, Ill.
MTT	Monowatt 1285 Boston Ave. Bridgeport 2, Conn.
NAC	National Co., Inc. Malden, Mass.
NYT	New York Transformer Co. 3rd Avenue Alpha, New Jersey
OAK	Oak Mfg. Company 1260 N. Clybourn Ave. Chicago, Illinois
OM	Ohmite Mfg. Company 3604 Howard St. Skokie, Illinois
PBR	Potter & Brumfield Princeton, Indiana
PRL	Price Electric Corp. 5560 Church Street Frederick, Maryland
RAMT	Radio Materials Corp. 3325 N. California Chicago, Illinois

LIST OF MANUFACTURERS

ABBR AND CODE NO.	MANUFACTURER'S NAME AND ADDRESS
SIC	Simpson Electric Instrument Co. 5202 W. Kinzle St. Chicago 44, Ill.
SLC	Shallcross Mfg. Co. 24 Pusey Avenue Collingdale, Pa.
SMO	Sangamo Electric Co. Converse & Lawrence Marian, Illinois
SNC	SNC Manufacturing Co. Oshkosh, Wisconsin
SPR	Sprague Electric Co. 149 Marshall St. North Adams, Mass.
STCT	Standard Transformer Co. 143 Dane St. Warren, Ohio
SWIN	Switchcraft, Inc. 1310 N. Halsted St. Chicago 12, Illinois
TEE	Teleradio Engineering Co. 101 Wall St. New York, N. Y.
UNT	United Transformer Co. 148 Varick St. New York 13, N. Y.
WAL	Ward Leonard Electric Co. 45 South St. Mount Vernon, N. Y.

ELECTRONICS DIVISION
GENERAL ELECTRIC COMPANY
ELECTRONICS PARK

25EL2

Printed in U.S.A.